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THE TRAINING OF CHEMISTRY TEACHERS, PROSPECTIVE AND IN SERVICE.

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Self-preservation is the first law of nature. When sudden danger threatens, an all but irresistible instinct drives each individual to seek safety for himself without regard for the welfare of other unfortunates who may be in even greater danger than himself. When the alarm is sounded in the jungle there is one notable exception to the usual rule and our admiration is aroused by the splendid heroism of the savage mother who forgetful of her own danger gives battle against overwhelming odds in order to protect her young from threatened harm against which they are unprepared to contend. If it were not for these two self-operating impulses many forms of life which we now know would have become extinct long ago. Each event of this sort gives experience which develops greater skill in avoiding danger, and so every species unconsciously improves with each passing generation. Thus it becomes the inherent duty of the adults of each generation to contribute something to the improvement of its kind.

We as teachers of chemistry are fostering a new science to the improvement of which we are definitely committed. Alarmists among our number have called attention to the threatened obscuring of our science by such intensely practical subjects in our educational system as manual training, domestic science, agriculture, etc. If chemistry is to win in this educational struggle for the survival of the fittest, we must see to it that this science is not only interesting to our students, but that it furnishes the means of mental development which is contemplated

in the very word education itself. Not only is it incumbent upon us to defend chemistry from immediately threatened obscurity, but a much more serious task confronts us. It has been strikingly said that "Education is an eternal obligation which maturity owes to youth." If we as teachers of chemistry are to measure up to all that is implied in this maxim, then we must see to it that we teach better than we have been taught in order that the next generation may be superior to the past. We have failed to fulfil our full duty to our generation unless our students make better chemists and better teachers of chemistry than we do.

There may be several ways of accomplishing this two-fold purpose; but certainly a very important method of approach is through the training of those to whom is entrusted the responsible task of teaching. A skillful teacher is an inspiration to his students, an asset to the science he is teaching and a builder of a larger and better chemistry although he may be handicapped with a dingy laboratory, scant equipment and an inadequate library. If a laboratory is provided with the most complete and costly equipment, chemistry earns little beyond the jealousy of the other departments if the person in charge is inadequately equipped for the work he has undertaken. The teacher is the most important factor required for the successful presentation of chemistry to the rising generation. If the teacher fails the whole effort is of little avail, but if the instruction is skillfully given great obstacles may be effectively overcome.

Among the qualifications which should be required of the prospective teacher of chemistry two stand out as absolutely essential if chemistry is to be successfully taught: (1) A knowledge of and an interest in the subject matter to be taught; (2) an ability to impart both knowledge and interest to the pupils. It was formerly true that many school authorities selected the given quota of teachers without respect to how satisfactorily the subjects to be taught would be cared for. It is perhaps much too common even now for a school board to select a teacher for social, religious or political reasons rather than for the educational qualifications required by the position which is to be filled. It is one of the most hopeful signs of improved educational conditions in the age in which we live to observe however that school authorities in increasing numbers are demanding special training for the teaching of special subjects. We chemists should lend our influence always to further this tendency, be-

cause the successful teaching of chemistry is one of the most thoroughly specialized undertakings in our whole educational system. Whenever opportunity is offered we should insist that the teaching of chemistry should be entrusted to someone with special training for the task. In like manner we should protest most vigorously against the practice, still too frequently met, of assigning chemistry to anyone whose schedule will permit it without respect to training, natural aptitude or experience. If chemistry is to be advanced to the position it deserves in our educational system the subject must be taught by teachers who not only know and love their subject, but who also have some skill in the subtle process of passing on to others their knowledge and enthusiasm.

I have heard warm discussions among educators as to whether a successful teacher is "born" or "made." It seems that such a discussion, as applied to the teacher of chemistry, is largely idle talk for he is of necessity both born and made. He is born as are other mortals without much if any indication of the particular activities which are to constitute his life work. He is made usually by coming under the influence of some inspiring teacher of chemistry in whose hands the subject becomes irresistible. There may be a few divinely inspired teachers who are essentially self-made, but most chemists can point back to some teacher whose name and influence have definitely molded their lives and their methods of teaching. Natural born teachers of chemistry are rarely met and one cannot help wondering if a little kindly training would not have increased their usefulness, however great that may be.

The first step in the training of teachers of chemistry involves acquiring a definite knowledge of the subject matter itself. This is usually accomplished by a course in a well organized college or university department. This portion of the training should be continued until considerably more ground is covered than the teacher is expected to teach. A person whose training in chemistry consists of only a single year's work in college is greatly embarrassed by the questions of his students regarding organic and physical chemistry, foods, vitamines, radioactivity and many other unexplored fields. The best training the world can furnish is none too good to meet the puzzling questions proposed by the youthful searcher after truth. In my opinion it is one of the ear marks of the true teacher to give an honest answer to every honest question. It tests our ingenuity, requires us to keep

pace with the recent advances in science and perhaps tries our patience, but it is well worth while, if the question indicates an actual hunger after knowledge. Remember that budding genius is always inquisitive and do your best to direct light to the bud in order that it may unfold into the full flower of scientific achievement.

The second step in the training of teachers of chemistry consists in developing the ability to teach. This work is generally well done in the normal schools of the country, but as a rule the colleges and universities are doing little in this direction. In the November, 1924, School Science and Mathematics, Miss Lucretia Cressey, of Teachers' College, New York, reports a complete survey of the state universities and prominent colleges throughout the United States. She finds only 15 schools in the country which are offering professional courses for the specific purpose of training high school teachers of chemistry. It is perhaps safe to assume that most of these 15 courses carry with them only a single hour's credit for one semester. Such courses are inadequate but they have material value, yet it must be admitted that our colleges and universities are not doing their full duty in preparing their graduates for the intricate and highly specialized task of teaching chemistry. In the absence of such training the college graduate does the best he can. Usually this consists in teaching in high school the material covered in college and by the same methods. This frequently produces a highly technical subject, devoid of human interest and lacking in adaptability to the problems of everyday life. Chemistry becomes a succession of involved theories, a maize of signs and symbols or a jumble of mathematical horrors all distantly remote from the events of the home, on the farm or in the shop. Taught in this fashion chemistry loses its position as a living, growing science, full of human interest and bristling with opportunities for making life fuller, richer and more worth while. We must keep in mind that we are a part of an educational system whose purpose is to prepare the coming generation to live better than would be possible if they were left to their own resources. We must keep constantly in mind that the benefits of the true scientific training are realized all through life, no matter where the life is spent. The ability to observe accurately, to compare impartially, to reason skillfully, to use the imagination sanely, and to think quickly is an asset in every life. Chemistry furnishes an excellent medium for the development of these mental traits and after all these should be the constant aim of the teacher.

No one can blame the college graduate for the method he uses in teaching chemistry. The fault rests with the college which expects its graduates to make successful chemistry teachers when they know only the subject matter of the course. If we as chemists have a love for our science and a desire to see the next generation better prepared than we were for the serious business of teaching, then it is our duty to urge colleges and universities to provide more adequate training for future teachers of chemistry. Teachers' courses should be established in schools and colleges and those of us who have the responsibility of selecting teachers should insist that candidates must have had professional training for the work which is to be entrusted to their care.

The training of chemistry teachers may easily be summarized under two heads: (1) That obtained in a fitting school, under the direction of an older person; (2) that which the teacher gains for himself, under his own initiative in the hard school of experience. Both of these are important but I believe the second is of the greater significance, especially to a group of experienced teachers. When we leave college our training as teachers is not complete for we are just entering upon the most important phase of our training. If we are to become successful teachers in the largest sense we must learn from experience and show continual improvement from year to year. If we do not progress we will be left behind for ours is a rapidly developing science. We must advance or we will lose ground and become hopelessly outdistanced. There can be no stationary engines in chemistry; either we must move with the traffic or be left behind by the procession.

The teacher of chemistry owes it to himself, his school, and his science to be continually improving his work. This he can do in many ways. First he can study the needs and interests of his community and adapt his chemistry accordingly. The city boy should be taught the applications of chemistry to the manufacturing processes with which he is familiar; the farm boy wants to know how he can become a better farmer by knowing something of chemistry; the son of a miner is intensely interested in knowing how chemistry aids in winning nature's riches from the depths of the earth. In preparing to present these applications as an integral part of the course in chemistry the teacher is broadening his own horizon and becoming a real factor in education, to say nothing of the increased interest and intensified motive on the part of the pupil himself.

In the second place the chemistry teacher should read habit-

ually in order to continue his own training as a teacher. This reading may well take two distinct forms: (1) Informational material which will keep one in touch with the advances which are being made with such bewildering rapidity; (2) professional articles which deal with the pedagogy of our work. Our own publication, SCHOOL SCIENCE and MATHEMATICS, is doing a splendid work in covering both the informational and professional sides of our reading. It should be read each month from cover to cover by every science teacher from coast to coast. In addition every chemistry teacher who can possibly do so should belong to the American Chemical Society because he then becomes one of an army of 15,000 chemists all striving for the advancement of our science. Each member receives the three publications of the society which alone are worth more than the cost of membership. There has also recently appeared a new magazine, solely for teachers of chemistry—The Journal of Chemical Education. Its first year has been successful beyond the fondest dreams of its sponsors and plans are formulating for greatly increasing its scope and usefulness. In addition to these journals which each teacher should read regularly, it is usually possible to persuade school authorities to put into the library for general use such publications as Science, Chemical and Metallurgical Engineering, Chemical News, and other scientific periodicals.

Finally the chemistry teacher can enhance his own training by associating himself with others who are doing the same sort of work. Membership in the Central Association of Science and Mathematics Teachers, and in the Teachers Associations which are now being organized in the various states under the patronage of the American Chemical Society is extremely stimulating in itself. While membership in such organizations is helpful, much greater good is accomplished if the member attends the meetings of his group, listens to the papers that are presented and joins in the discussions, for he will then be benefiting himself and encouraging his neighbor. Such exercises are worth all they cost and will help in keeping us from becoming old fogies before our time.

SOME AIMS AND METHODS OF THE TEACHING OF SECONDARY SCHOOL BIOLOGY.

By Jerome Isenbarger

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Biology is the study of life. In its broadest sense it includes the general subjects of medicine, agriculture, psychology, sociology—for all of these are studies of life. As a secondary school study, it comprehends such special subjects as physiology, comparative anatomy and embryology, but it is not a combination of them. It has been said that the universities and colleges have been a dead weight upon the high schools in progress of biology teaching. The evolution of adaptation of subject matter and methods of teaching to the adolescent stage of development has gone on in spite of the colleges and universities. I was taught in a normal school class that as a subject came to be utilitarian in its bearing, it decreased in its educational value. Certain subjects were recognized as of practical value in preparing one for a vocation, but to others there was ascribed a sort of dispensation which gave them the exclusive agency in the dissemination of the mental training necessary to bring about the desired subjective state known as culture. It is a commonly accepted belief at the present time that a subject can be practical and at the same time, cultural in its effect. I am inclined to the belief that we have an evidence of a distinct progress which has come in educational theory within the last two decades, in the changes which have given us the conception of culture as it is generally accepted at this time.

The principles set forth in the report, "Cardinal Principles of Secondary Education," of the N. E. A. Commission on the Reorganization of Secondary Education represent in clear and concise language the thoroughly modern view of the ends of education. In condensed form, these principles are:

1. The aim of education is the development in the individual pupil of the knowledge, interests, ideals, habits and powers whereby he may enjoy the fullest possible measure of development and happiness; and whereby he will find his place and use that place to contribute through his activities to the well-being of his fellows and to the well-being of society as a whole.

2. The main objectives are: health, command of fundamental processes, worthy home membership, vocational guiding and training, citizenship, worthy use of leisure, and ethical character.

3. Changes in courses of study and subject matter of instruc-

tion must be made from time to time to conform to changes in society, changing school conditions, and sound educational theory.

Then, the curriculum must have a social basis and subjects and subject matter which do not have a social bearing should be eliminated. No topic should be left in the syllabus for which a clear case, on the basis of specific aims, cannot be made. When our biology courses are those which have been carefully worked out to fit local conditions as to needs of the community and interests of the pupils, rather than rehashed college courses, then and not until then can we expect the subject to find its deserved place in the program. The cause for the indictment of the colleges and universities which formerly held has been removed by many of them and they are now offering excellent courses organized to meet the needs of teachers in the secondary schools.

Considering the breadth and depth of the subject and nature of the subject matter, the importance of biological training in the life of an individual can not be overestimated. From a wide and varied experience in teaching in schools from elementary grades to college, I consider biology unique among secondary school subjects, when properly taught, in serving a greater number of the ends of education than any other single subject. Support for this contention requires a discussion of purposive selection of material and efficient methods of presentation.

Of prime importance in the course is health instruction. Man is seen in his relation to other organisms, the master of all he surveys, but mastery is conditioned by knowledge of such subjects as, bacteria, injurious and beneficial; insects and disease; parasitic worms; mammals as carriers of disease. Knowing the requirements of plants and animals leads to a better understanding of the requirements of human beings. Following the interests to which the study of nature leads takes one afield into pure air and sunshine, affording healthful diversion in the way of a worthy use of leisure. Knowledge of natural law and of certain penalty for disobedience tends to rational living. Knowledge of bacteria and other parasitic microorganisms stresses the importance of personal and civic cleanliness. That training which helps the individual to live a rational life and retain health is social in the highest degree as that which adds to the efficiency of the individual is reflected in the institutions of which the individual is the unit.

The biological sciences teach as no other subject can the fundamental knowledge and relationships of sex. The approach being gradual and natural, beginning with the reproductive processes of the lower plants and animals and continuing with the higher forms including the mammals, a wholesome attitude is secured in mixed classes without offense. The facts of sex and reproduction are considered a normal part of knowledge. The method of treatment depends upon the community and upon the teacher.

The pupils under our charge are the potential parents of the next generation. With the newspapers full of accounts of marital triangles, infidelity to the marriage relation, divorce proceedings, and other forms of social scandal; with the bold and abnormal sex themes depicted on the motion picture screen; with obscene and sensational pictures and literature in circulation; and with the shameless manner in which children are misinformed in matters of sex by their elders—with all of these influences at work to pervert the minds of our youth, what kind of parents are we to have for the next generation? Without being a gloom chaser one must face the facts as they are. Young people are naturally hero worshipers. What kind of heroes are we permitting them to set up? All agree that something must be done to counteract the unwholesome influences of the environment. Parents, doctors, preachers have made feeble attempts and have failed pitifully. Fifteen years of experience in teaching biology in secondary schools, large and small, and in the college, have convinced me that only in nature study and biology can facts of sex and reproduction be presented in a normal way. The kind of instruction of which I am thinking should be begun early in the grades and continued in the high school courses and in the college. The pupils are eager for facts and I see no good reason why ignorance should not be replaced by information. In so far as I know, no pupil or parent has ever objected to the plain and straightforward way the matter was presented in my classes. I know of no tactful biology teacher whose experience in that regard does not coincide with mine. It is not a theory with conscientious biology teachers who understand their responsibility, but a fact. Considering this as a secondary school problem, I offer this as an argument in favor a year of biology required of all second year pupils, providing that the course be not of the stereotype sort, but a live course based on the interests of the pupils and on the welfare of society at large. This required

course should be one in general biology. Then, in the larger high schools, there should be optional courses in botany and zoology later in the course.

It is important that the home and family be stressed as the ideal fundamental unit—that the ideal relation consists of an unfaltering devotion of one man and one woman in a home where there are children. This brings forth the question of eugenics which may be approached through discussion of laws of plant and animal breeding, pedigreed seeds, pedigreed animals, and something regarding desirable and undesirable strains in human development.

Except in the case of the study of the laws of heredity, there should be no separate lessons on sex and reproduction. The facts should be brought out wherever this may be done in a perfectly regular way, in connection with the other work of the course. The selection of animal and plant forms should, in general, be governed by the normal interests of the pupils. In a general course, the forms which should be used, I would say, almost to the exclusion of all others are insects, birds, mammals, fungi and seed plants. These forms are more generally related to the interests of man and the pupils are interested in those forms as animals and plants.

While secondary school biology makes no pretense of preparing for a vocation in particular, yet the training offered by this subject should be an aid to the youth in the difficult problems of finding a life-work in which he will be happy because of peculiar fitness for that particular service to society. Vocations to which the study of biology may lead are agriculture, dentistry, medicine, nursing, housekeeping, teaching, horticulture, forestry, art, pharmacy.

The term, "civic," has been extensively used in connection with the name of certain courses and texts in biology to indicate the social bearing of the subject. The inferences are that these courses offer training in citizenship. The following statement from the text of Hodge and Dawson indicates the background of such a course: "Civic biology consists in that group of problems in the control of living nature to solve which requires that a community unite in working together intelligently. Such problems must be made the vital part of education of every citizen for in no other way can they ever be solved." Flies and mosquitoes allowed to breed on one's premises may prove a menace to the comfort and health of neighbors. Scale insects on fruit and

shade trees and weed seeds are no respectors of fences. An important lesson to drive home is that each individual's carelessness or ignorance affects other people. The fact that some people allow the brown rat to breed costs the country more than $500,000,000 every year. Learning the fact that a large percentage of the food of birds consists of injurious insects and injurious rodents stresses the protection of birds as a civic duty. Information along biological lines presses duties of the citizen as a neighbor, a voter and a taxpayer. Quoting again from Hodge and Dawson, "The problem of civic biology is to make it possible for every one to know what these forces are, for good or for ill, and to understand how to do his part for his own good and for the good of the community."

A feature of biological study which should be mentioned before leaving the consideration of aims is the fact that it forms or helps to form life-long interests leading to active out-door diversions. Training for a vocation needs no argument in its favor when considered by the man of affairs. The importance of training for leisure is ordinarily not thought of. It is here that the nature study side of elementary courses in biology, botany or zoology is of special value in developing and deepening the natural interest in the wonders of nature in the country, at the seashore, on the mountains, at home or abroad. Biological interest leads from an apartment in the congested portion of town or city to a bungalow with grass and trees in the suburbs where interesting avocations may be carried on. Nature study in biology should cultivate appreciative observation which will ever tend to an appreciation of beauty.

With the changes in the point of view of biology teaching there have come much new subject matter and radical departure in methods of teaching. The old-fashioned zoological laboratory in which a series of dissections were made in order to see an evolutionary chain has practically disappeared, in so far as the high school is concerned. We consider such dissection now a useless waste of time. Interests are mainly in living things. No laboratory procedure should be followed for which a good reason can not be given on basis of the main interests of the pupils and educational value. It has been shown by Cunningham Cooprider, Anibal, and others that, in so far as getting facts is concerned, lecture-demonstration methods of instruction are more efficient than the laboratory. Much of the work which has been done at the expense of time and energy in the laboratory

can be accomplished more satisfactorily and in less time in the class-room. The compound microscope is not essential to good biology teaching, in the second year of the high school. Microscopic projection has reached a stage of simplicity and ease of manipulation which recommend it highly as a method of instruction. Even in classes in the higher grades or colleges where microscopic examination of material by the student is desirable, the projection microscope is a valuable adjunct for purposes of demonstration preceding a laboratory exercise.

Every biology course should include field work. Studies of birds, insects, flowers, trees, and general animal and plant relations are not complete without a study of the plant and animal forms in their natural surroundings. Sanitary surveys of the neighborhoods of the pupils are interesting and valuable in calling attention to the various sets of conditions which make a neighborhood a desirable or undesirable place for a home. Field trips should be carefully worked out in advance. Pupils should have definite information as to object of the trip and a written report should be required in every case. This, as with much of the other work of the course should be worked out in the form of a solution to a problem.

In summarizing, I desire to quote from a paper from Education by John C. Page. "Elementary zoology is a field of unusual potentiality for social service. It brings to the humblest rural school many messages that humanity needs. But we need teachers and we need university courses that will give us teachers. We need teachers with a vision, with a sense of proportion, with a sense of correlation, with broad human sympathies, teachers that can root the study of life down into the very foundation of things—not teachers who will give the pupils hard, mechanistic, unfeeling and animal-like views of life, but teachers who can pause and say

> 'Flower in the crannied wall
> I pluck you out of the crannies,
> I hold you here, root and all in my hand
> Little flower, but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man is.' "

THE EVOLUTION OF SCIENCE BOOKS[1].

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It was my good fortune in September of this year (1924) to spend some weeks in the Library of Congress at Washington. With true hospitality they invited me to make myself at home, take anything that was loose, and if I didn't see what I wanted to ask for it. With the freedom of the stacks, I found recreation from more serious study in playing games of "hide-and-seek" with the books, and working out some problems that were not learned, only interesting. One of these I am happy to have the opportunity of sharing with you.

The Earliest Science Books.

Bookmaking is a very old industry. It was an important profession in ancient Rome. Grecian slaves wrote on Egyptian papyrus for centuries before the Christian era. Tradition, and sometimes history, tells of enormous libraries in which were collected and catalogued the written wisdom of the age.

Probably the first book on *mathematics* is an Egyptian papyrus now in the British museum. It was written by Ahmes earlier than 1700 B. C. On being deciphered in 1877, it proved to contain real problems for solution, and specific "directions for obtaining the knowledge of all dark things."

Archimedes of Syracuse (287-212 B. C.) was the first great *physics* writer. His material must have come principally from his own experiments, for the science was new indeed. It may be noted in passing that Archimedes is the only physics teacher, ancient or modern, for whom we have positive written evidence of his having ever taken a bath.

Aristotle of Athens (384-322 B. C.) was probably the earliest *chemical* author. Of his 146 separate treatises, many dealt with the four elements; earth, air, fire, and water. Almost the oldest actually printed book I saw in the Library was on the chemical works of Aristotle, written by Albertus Magnus (1193-1280) and printed in 1513, not so very long after Johannes Gutenberg started this book publishing business with his movable type. The oldest science book I saw was a German text on "the Art of Distilling and Compounding," credited to Hieronymus Brunschwig, and printed in 1512.

Of the beautifully written manuscripts of the Middle Ages

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1 Read before the All-Science Section, Association of Science and Mathematics Teachers, Chicago, November 29, 1924.

now in existence, few are older than the year 1000 A. D. The printed ones, of course, date from 1450. It must have been no easy task to get a book published in those days. Yet, as one handles the yellow brittle paper between the leather backs of these venerable science volumes, he cannot fail to be impressed with the earnestness, accuracy, imagination, and skill of explanation which these ancient writers had. Naive they may appear, but not stupid; they were blind as we see by our present light, but not dull.

The Beginnings of General Science.

What was the first *general science* book? With all respect to a popular impression, the honor cannot go to Miss Bertha Clark. General science seems to have existed since the beginning of time. Since science was, it is. Although I could not find the first, I traced them back century by century, age by age, until, like the skeleton of *eohippus*, I reached the primitive ancestor of the modern breed of general science texts. John Baptista Porta, a Neapolitane, wrote a little book of four chapters when he was 51 years old (1566) and a big one of twenty when he was 65 (1616). Each volume was entitled "Natural Magick." The last was translated into several languages, including English in 1658. That you may be convinced of its true general nature, I ask leave to present the titles of its chapters.

Porta's Book of Natural Magick wherein are set forth all the riches and delights of the natural sciences.

1 of the Caufes of Wonderful things	11 of Perfuming
2 of the Generation of Animals	12 of Artificial Fires
3 of the Production of New Plants	13 of Tempering Steel
4 of increafing Household-Stuff	14 of Cookery
5 of changing Metals	15 of Fifing, Fowling, Hunting, &c.
6 of counterfeiting Gold	16 of Invifible Writing
7 of the Wonders of the Load-Stone	17 of ftrange Glaffes
8 of ftrange Cures	18 of ftatick Experiments
9 of beautifying Women	19 of pneumatick Experiment
10 of Diftillation	20 of the Chaos

This work had competition in its age. Joannem Philippum,

with his "Technica Curiofa" of 1644 was equally comprehensive. He published, not mediaeval philosophy or argument, but actual experiments, with diagrams and full directions. His pronouncement is such easy Latin that I ask you to digest it in the original:

Technica Curiofa, of Joannem Philippum, 1644.

Libris XII comprehenfa, quibus varia Experimenta, variaque Technafmata, Pnevmatica, Hydravlica, Hydrotechnica, Mechanica, Graphica, Cyclometrica, Chronometrica, Automatica, Cabaliftica, aliaque Artis arcana ac miracula, rara, curiofa, ingeniofa, magnamque partem nova & antehac inaudita, eruditi orbis utilitati, delectationi, disceptationique proponuntur.

For versatility and originality I will match these general science texts of Porta and Philippum against any of their modern imitators.

The Versatility and Industry of Science Writers.

As one glances through the science books of the ages, the wide variety of knowledge possessed by some men becomes impressive. The subtle meaning expressed in the French noun *savant* applies to such a one; he seems to be an authority on almost everything. Out of several I may select a living author, Archie Frederick Collins, as an illustration. Born 1869 in South Bend, Indiana, he was educated at the old University of Chicago. He invented a system of wireless telephony which in 1899 spanned a distance of eight miles. Who's Who in America credits him with the authorship of 50 books and 500 articles. It takes a whole box in the library to hold his cards. He has written on practically every phase of science or invention in the air above, the earth beneath, and the waters under the earth. He now lives in London because of his activities in the study of spiritualism, thus adding a fourth dimension to the sphere of his interests.

Others, who may not seek to scatter truth with a shotgun, yet surprise us with their prodigious output. What a worker must have been George Louis le Clerc, compte de Buffon (1707-1788) who when only half through his span of 81 years had written his monumental "Natural History of the Globe." Sixteen volumes of natural history, 9 of birds, 6 of minerals, 2 of reptiles, 6 supplemental; 39 in all, big volumes of 350 pages or more, superbly and lavishly illustrated with wood engravings. Much of his material is obviously first-hand; he must have scoured the earth to get it. One edition after another followed; the complete work was still being translated into English as late as 1841, and reprinted in French in 1849.

I must also mention Darwin, whose 23 books and 81 pamphlets are all masterpieces of personal research, and Fabre, with more than 30 books on natural history, as similar examples of the marvelous productivity of an industrious scientist. An energetic scientist can run a close second to G. A. Henty and his countless boys, to John Russell Coryell and his endless Nick Carter; or to Martha Finley, who, when she died, had nursed Elsie from childhood through grandmotherhood, and was preparing for another generation.

Cranks, and What They Turn Over to Libraries.

One cannot search through the book shelves very long without finding the cranks. There are three almost certain signs of a crank's book; the frontispiece will be a portrait of the author, the title page will have the phrase "published by the author," and the preface will hold up its hands in horror and raise its voice in protest over some generally accepted belief. I believe I can classify crank authors into two groups; first, those who are honest and earnest, but have the wrong slant on things; second, those who are sensational, sarcastic, and full of tricks, and who probably have a method in their madness.

A fine illustration of the first is a little volume entitled "Whatever Is, Was." Some topics discussed are these: "In nature there are no such things as cause, effect, generation, growth, nor death." "There is no time, no past, no future." "The Self-existence of the Universe." "A new theory for the origin of the world."

Another volume, quite pretentious, is "A Journey to the Earth's Interior, or, Have the Poles Been Discovered?" by Marshall B. Gardner, "author of the theory of a central sun within the earth's interior." Published by the author at Aurora, Illinois, the first edition, 1913, of 69 pages, was followed by the second, 1920, of 456 pages. Wonderful colored plates, show Sun Number 2 inside the hollow earth, with the light streaming out and causing the aurora borealis. The inside illumination of our neighbor planet Mars is similarly shown, with the vivid polar spot of light that has been erroneously pronounced an ice cap. There is a fine picture of the author as frontispiece. The work follows every good scientific practice, including a four-page bibliography referring in detail to investigations of T. C. Chamberlain, Henry Davenport, Cammille Flammarion, Joseph LeConte, Percival Lowell, Simon Newcomb, F. R. Moulton and

others, all of whom lend their confirmation to the theory.

Certain topics seem to attract the sarcastic, vituperative crank. In the 1850's it was structural geology, especially in regard to the age of the earth. In the 70's and later the attacks were on biology. The one that struck me most strongly between the eyes was "God—or Gorilla," by Alfred W. McCann, food-reporter of the New York Globe, published in 1922. It has some of the finest pictures of monkeys I have ever seen. In the preface the author announces, "this exposure will shake our entire educational system to the core." Although the explosion has been delayed, I am momentarily expecting it. If any of you observe tremors in your corner of the educational system, hold on tight!

The Press of the Nations.

One cannot pass back and forth along the shelves of a very large library, and not be impressed with the overwhelming predominance of a few nations in the publishing industry. This business, like most others, depends upon the market; books are not produced where they are not used. It is astonishing how few of the earth's population use literature. The savage races live wholly without it; the barbaric races produce so little that it is a curiosity. Life is so hard in most of the civilized nations that their books supply only the most urgent local necessities. The Balkan states, the South American republics, for example, do not print much. Spain is not a large producer.

The four great publishing nations are the United States, England, Germany, and France, as far as science books in the Library of Congress bear evidence. The common needs of human minds appear in the similarity of certain types of books in each language. The pictured encyclopedias of science, the "Wonder Books," the "Marvels" books, the "Stories" of science and industry present a common appeal.

It is interesting to note the extent of translation between these four languages. The honor of being read in a foreign tongue comes to many authors. For example, Edward Suess, the geologist, wrote "Das Anlitz der Erde" in the early 80's, and the German editions ran from 1885 to 1909. Editions of Suess, "La face de la terre," came out of Paris from 1897 to 1918; Suess, "The Face of the Earth," from London from 1904 to 1909; and Suess," La faz de la Tierra" issues from Madrid in 1923. Fabre's works have gone into many languages. R. A. Millikan's "The

Electron," as "Das Elektron," has no doubt helped many an inquiring German spirit.

America, a Field for British Books.

Britain is paying her war debt with books. Workers on the island may be idle, and receiving doles, but writers are not. Simply written, lavishly illustrated science books for home reading are being turned out in a stream by British presses. When I was in Wanamaker's Philadelphia store seeking gifts for my children, eleven out of the first dozen popular science books I picked up were from across the water.

There are certain ways to readily distinguish a British book. First, the weight of the volume is frequently so light as to surprise you when you pick it up. The covers are usually gorgeous. There are sure to be advertisements of all sorts of merchandise covering several leaves front and back. Our enterprising publisher of Fall's "Science for Beginners" has evidently "taken a leaf out" of British books with the full-page advertisement of Ivory Soap. British books rarely bear a date, they are timid about telling strangers their age. The Library of Congress stamps the date of receipt, so if a book is really over 21, we may know it.

There is apparently a most beneficial working agreement between American and British publishers to act as each other's agents. Many, however, have houses on both sides of the water; the New York branches of Sir Isaac Pitman & Sons, John Lane, Blackie & Sons, and others, being balanced by the London branches of Appleton, Lippincott, Longmans, Macmillan, etc. This interchange of published material is a splendid thing. Scientific knowledge should never recognize barriers of either race or politics. Its spirit should destroy provincialism, and emphasize common human needs and the hope of universal brotherhood.

Some Needed American Books of Science.

There are certain fields of popular science covered by British books for which we have no American counterpart. The British treatment, impregnated with local references and idioms, cannot well serve the American child. Sir Isaac Pitman, London, has a series of 81 little books, perhaps more by now, on "Common Commodities and Industries." They are intensely interesting, but you may readily imagine how inadequate the volume on "The Petrol Motor Industry" would be for American youth. Then, "Telegraphy, Telephony, and Wireless" finds it hard to

give as generous credit to American inventors as *we* may think they deserve. But what splendid stories they are!

There is another series, "Peeps at Industries," by A. & C. Black, London. The nearest approach to an American series written in the same spirit are the "Department Store Merchandise Manuals," published by The Ronald Press, of New York. These dozen or more volumes present most instructively the sources, manufacture, and sales value of a considerable variety of the smaller things we buy. Harper's "Handbooks for Boys," a modern and growing series, is one more helpful American production. The "Stories of Science," published by Appleton's years ago, are now hopelessly out of date.

In the Library of Congress, for each rather narrow field of knowledge a catalog number and shelf space is set aside for "popular and juvenile works." It is astonishing for how many practical aspects of science this space is empty, or occupied only by books of past generations. What a story some man could write about the great hydroelectric plants, the great steam generators, and the high-power transmission lines of the superpower networks of the East, the South, and the West! There are romances of many phases of agriculture, technology, medicine, that are unsung.

New and Active Fields.

There are certain recent interests of people that have brought new books with a rush. Ranging from technical to juvenile, with abundance of intermediate popular volumes, the books presented show what a productive literary nation can do on demand. For example, the radio shelves are nearly full, the British crowd the allotted space with volumes on aviation, and the new works on a phase of human activity that is fast becoming a science—touring and camping—are inspiring in number and practical interest. All forms of outdoor activity, boating, fishing, swimming, hiking, have become literary fields. The value of these as supplements to more formal scientific instruction is apparent to every teacher of adolescent youth.

The Short Lives of Science Books.

One thing that might be expected to discourage the writers of science books is the knowledge that its life is almost sure to be a short even though merry one. They may not expect the rewards of a classic author, whose child of his youth supports him in old age. Science progresses too fast for that. Waldemar Kaemp-

fert's "The New Art of Flying," of 1911, would cause loud guffaws among the boys with its pictures of box airplanes and monoplanes with wires above and below the wings. F. A. Collin's "The Wireless Man on Land and Sea" of 1915 shows the *Mauretania* with a crystal set. There is a tendency, which ought to be discouraged, of reprinting an old science book with a new title and cover. "From Beacon Fires to Radio," published by Harper & Brothers under date of 1924 is a direct reprinting from the plates of "Masters of Space," 1917, and does not contain added material. Such books are good only as history; youth wants *current* information in the field that interests him.

Science books should be new, or thoroughly revised and brought up to date at frequent intervals. Authors and publishers owe this to the public whom they seek to instruct; a debt is also due to those research workers who are responsible for scientific progress. If we are satisfied to teach the science of ten years ago, what respect do we show to those who push the frontiers of science ever forward. As these pioneers explore the land, we should be ready to move in and possess it.

There are some exceptions to the butterfly existence of a science author's works. In *physics*, John Tyndall's (1820-1895) accounts of his researches are still standard reading. The popularity of this Irish scientist, who lectured in the United States during 1872 and 1873, was not due to the fact that he gave all the proceeds of his tour to foster physical research in this country, but to the solid content, popular style, and brilliant illustrations of his numerous lectures, and more than a dozen books. New editions of Tyndall's works were brought out as late as 1904 by Appleton, and are still on the market.

In the domain of *biology* they are still reading Darwin's books, both on account of their classic place in scientific literature, and the large amount of free advertising they are receiving from pulpit and press. The latest edition of the account of his voyage around the world was printed in 1910 by the Cambridge Press.

One *chemist* whose works are still popular is Michael Faraday (1791-1867), whose "Chemical History of a Candle" was reprinted by Collier's as late as 1910. In *mathematics* there are direct printings in this country, not mere commentaries, of certain works of Euclid dated 1908. Newton's latest edition in England is 1871, in Germany 1908. Archimedes is a posthumous American author of 1909, French of 1921, and German of 1923. Some scientists, indeed, write for time, possibly for eternity.

Subjects That Will Not Die.

Some topics of science are apparently cat-like in their hold on life. You would think that in this day of motor transportation no one would present a book on *horseback riding* to a world with its foot on the gas. Yet we have Fleitmann's "Hacks and Hunters," 264 pp., Scribner's, 1921; Count de Sousa's "Elementary Equitation," 338 pp., Dutton, 1922; De Bussigny's "Equitation," 370 pp., Houghton Mifflin, 1922; and Maddison's "Riding Astride for Girls," 263 pp., Holt, 1923. These big, substantial books are the quite modern authorities on a science that began when the cave man captured ponies mired in an Eocene bog. This science of equitation plodded patiently across Egyptian deserts, and rushed storm-like over Arabian sand in the dawn of history. It thundered in the battlefields of Europe as the greatest accomplishment of a warrior knight. It reached its climax of action on the western plains of America, where the cowboy with horse sense and the horse with almost human instincts raced to and fro welded together as one flesh. It achieved its highest refinement in the middle century days of our grandmothers, when it graced the Sunday outings of every gallant gentleman and fair lady, and made its way into every book of etiquette. But we had thought the science dying as the wheel replaced the reins and the gas pedal supplanted the spur. But a science that can turn out more than one big book a year is not yet dead, not even sleeping.

Tragedies of Failure.

As one takes down book after book from the shelves of the Library of Congress, where a complete list is to be had, one is sure to be impressed with the many unfamiliar names found among the authors. Any one of us, as science teachers, are familiar with the most important writers in our field. How about the host of writers who did not become important, though they gave their best of mind and heart in the writing of their books? Sometimes the fault is obvious, but I became astonished at the number of good books of which I had never heard, nor seen in any list or library. The first clue to this distressing fact was the discovery of some chemistries, published within ten years, which were absolutely new to me. "How many chemistries," I wondered, "have been published within the years of my own experience in the subject?" Excluding all reprinted editions, I found that there had been written and published 117 texts in general chemistry for high schools and colleges from the year 1900 to date.

How few of these, comparatively, have rewarded their authors with either fame or wealth? Many—indeed most—authors of chemistry texts have received for their pay only the by-product of their own self-improvement.

The large publishing companies are wary of failure, hence there are several houses in this country whose chief business is printing books for authors, at the author's expense. Many of you, no doubt, get letters from them regularly, soliciting manuscript. This business is, of course, entirely legitimate, and renders a real service. There have been a few happy instances where the author was fortunate with a book that proved unexpectedly popular, and brought him far larger returns than mere royalty would have done.

Delayed Rewards.

Sometimes the bread cast upon the water has really returned after many days. Jean Henri Fabre, the French naturalist, started his scientific career as a chemist. A promising young teacher, he rose rapidly to a university professorship. His popularity with the students was great, but an educational experiment which he introduced, the teaching to classes of young women in an informal way the interesting secrets of nature which only men were supposed to know, caused his dismissal, with the connivance, as he says, "of old maids who saw in the educational innovation nothing but the abomination of desolation." He then invested both his knowledge and funds in a madder factory, just on the eve of the discovery of a way to make synthetic madder, or alizarine. Ruined, and facing the necessity of supporting his family of five children, he began to write. "Let us try another lever" wrote he "and resume rolling the Sisyphean stone. Let us seek to draw from the ink pot what the madder vat and the Alma Mater refuses us. *Laboremus!*"

Throughout the years he lived in obscurity and actual want. His books sold slowly. Many of them being exclusively his personal observations, it would require days in the field to secure data for a single line. He became the world's supreme authority on insect life, but the world received him not.

When he was ninety, a poet discovered him, and so strongly and eloquently plead his cause in every corner of France, that the government took notice, and parsimoniously gave him a grant of $33 a month. A jubilee, engineered by the poet, took place in 1910, and all official France journeyed to his humble cottage. Then came prizes and letters, the Gold Plaque, the Linnean

Medal, and more money. Victor Hugo had hailed him "Homer of Insects;" Edmund Rostand proclaimed him "Vergil of the Insects;" Le Gros sweetly applied the name "Poet of Science" to him. He died in 1915, full of honors that had come suddenly, but very, very late.

Then—would you believe it—his books began to sell. After the Jubilee had attracted attention to him some English translations were made of his works. The American editions, in the land where an author may really get his name printed with the income tax returns, have all come since 1919. Relatives reap the harvest the grand old master sowed.

The Glory of Success.

But some sow, and also reap. There are certain causes that bring early fame and abundant recompense; the personality of the author, the prestige of his institution, or the timeliness of his message. We take off our hats to Liberty Hyde Bailey, of Cornell, whose "Principles of Agriculture," first published in 1898, has gone through twenty-six editions. Editor, author, philosopher, poet, this glorified farmer has seen many others of his books bring fifteen or more crops from one planting. We feel like taking off our hat and shoes as well in the presence of E. E. Slosson, creator of Creative Chemistry, consultant at the rejuvenation of Alexander Smith's "Chemistry," and general broadcasting station of popular and authentic science. His combination of wit and accuracy have made him more than a mere author or lecturer; indeed, he is a national institution!

By avoiding the one inexcusable crime of the writer, *dullness*, men like these have set a style of popular scientific presentation which marks an achievement in the evolution of science books.

EXPERTS FIND FAULT WITH HOME-MADE APPLE SAUCE.

Mother killed a valuable vitamin when she made apple sauce by the old recipe, Edward F. Kohman, Walter H. Eddy and Victoria Carlsson charge. Vitamin C, the vitamin which prevents scurvy, was the one destroyed. The experts told how the fruit should be prepared to preserve this vital food factor and also pevent corrosion of cans after canning. All fruits use oxygen in a breathing process not unlike the breathing of animals. It is this oxygen in the fruit which destroys the vitamin, and the way to prevent the destruction is to get the oxygen out of the apples before the cooking starts.

This can be done by peeling and quartering the apples and keeping them overnight under water containing about one per cent. of salt. Deprived of oxygen supply from the air in this way, the apples use up the oxygen in their tissues. This drawing of the apples saves Vitamin C.

INFORMATION VERSUS TRAINING: AN EXPERIMENT IN LABORATORY METHODS.[1]

Harold Sellers Colton

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Statement of Problem:

A review of the laboratory courses which are followed in the elementary zoology courses in our colleges, reveals the fact that different methods of instruction are pursued in different laboratories; and upon these practises, a literature is accumulating.[2] We observe a mild controversy over principles and types; discussions concerning the efficacy of the method of discovery compared with the method of verification; and whether training in method is more important than mere content of information. In the following paper the author attempts to determine by a controlled experiment the differences between *laboratory* work based on information and *laboratory* work based on training.

The Experiment:

The class in General Zoology at the University of Pennsylvania, in the fall term, is a large one numbering in 1921 to 1922 a little under three hundred students. Among those students are about one hundred and fifty males who are preparing to enter the Medical School. These students, with their unity of purpose, form an ideal group for an educational experiment. Therefore, of these, ninety-six students were selected at random, and at random were placed in four sections of twenty-four students each, two of the sections meeting in one block of hours and two in another. Two instructors concerned themselves with the experiment. To each instructor were assigned two sections: one in which information was the keynote and a second in which training was stressed. This arrangement, as far as possible, controlled the personal element, the effect of which can be measured in the final results. The information sections followed very closely Shull's laboratory guide on the Principles of Animal Biology[3] which was supplemented by demonstrations and special lectures. The training sections followed the guide issued by the Zoological Laboratory of the University of Pennsylvania, of which the underlying principles have been very fully described by Wenrich.[4] These training sections were presented with very few demonstrations and with very few lectures. Both series of sections made use of Shull's Principles of Animal Biology as a text book.[5] In one series, the book was followed carefully with assigned readings; in the other, less reference was made

to it. Altogether, the two methods of instruction were presented as carefully as one man can practise them.

It must be emphasized, however, that we are not making a comparison between an information course depending on book and lecture work alone, and a training course involving laboratory work. Nothing is further from the truth. The experiment involves a comparison of two laboratory methods. In the former a large amount of material is handled by the student in a casual way. In the latter, a small amount is carefully studied. In both a record was required, but a lower standard was maintained for the record in the case of the former group than in the case of the latter.

To measure the effect of these two methods, at the end of the term a comprehensive examination was devised. This examination included the following topics:

(1) *Observations*—A drawing of a portion of an arthropod which had not been studied in class. This was scored on the number of details recorded.

(2) *Drawing*—The same drawing as above scored on proportions and character of the work.

(3) *Constructive Imagination*—A drawing of an imaginary section of an animal that had previously been dissected in class. The students were allowed to handle the material during the examination, but were not allowed to cut or injure it in any way.

(4) *Judgment*—

a—Cross out errors in a statement.
b—Underline theories once and facts twice in a paragraph.
c—State in one sentence the main idea of a paragraph. (Limit 25 words).

(5) *Reasoning from Facts*—A problem in genetics in which all the data is given.

(6) *Information*—Ten questions based on topics taken at random from Shull's Principles of Animal Biology.

(7) *Vocabulary*—Ten words taken at random from a glossary in Shull's Principles of Animal Biology to be used correctly in sentences. This proved difficult to score accurately.

(8) *Organization*—Outlines of a speech on an aspect of Eugenics.

(9) *Morale*—Recorded for each student at the end of the year by the instructor, giving him a grade.

The topics were all scored separately and recorded on cards. From these, the frequencies were plotted for each section and the means and standard deviations computed. The differ-

ences of the means between the training and information sections were then derived with respect to each separate topic. To test the significance of this difference, the probable error of the difference was computed. (For the benefit of those interested the detailed tables and their interpretation are on file at the Zoological Laboratory of the University of Pennsylvania.)

CONCLUSIONS:

An inspection of these tables showed that all differences fell under three times their probable errors. This was interpreted to mean that the differences were, in all nine topics, insignificant. In treating the data in other ways, a few significant differences stand out, particularly when we compare the means of sections under different instructors, irrespective of method used in instruction. The sections of one instructor in one topic significantly higher than the section of the other instructor.

Although a comprehensive examination could distinguish no difference between laboratory sections conducted from the point of view of information and laboratory section conducted with the point of view of training, the reader must remember that the comparison lies between methods of *laboratory instruction* and not between *laboratory methods* and *non-laboratory methods.* Notwithstanding the negative outcome of the experiment, nevertheless practical results flow from the study. Since the personal influence of the instructor, within certain limits, is more important than the method of laboratory study, then the individual instructor can be given considerable freedom in the matter of laboratory routine. In a course divided into a large number of semi-independent sections this is an important administrative principle.

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[1]The author wishes to thank Dr. Charles L. Parmenter for his share in the experiment.

[2]Wenrich, D. H. The General Zoology Course. Science N. S. Vol. 54, p. 120, August 12, 1921.

[3]Shull, A. F. Biological Principles in the Zoology Course, Science N. S. Vol. 48, p. 648, December 17, 1918.

[3]Shull, A. F. Unity and Balance in the Zoology Courses, Science N. S. Vol. 51, p. 312, March 26, 1920.

[3]Shull, A. Laboratory Guide on the Principles of Animal Biology. McGraw-Hill Book Company, 1921.

[4]Wenrich, D. H. loc. cit.

[5]Shull, A. F. Principles of Animal Biology, McGraw-Hill Book Company, 1920.

PROMPT ACTION ON UNIONTOWN SURVEY REPORT.

After a survey of the school-building situation in Uniontown, Pa., in February, 1924, the United States Bureau of Education suggested a definite program of improvement. In April the people voted 8 to 1 in favor of a bond issue of $600,000 to erect and equip two junior high school buildings as recommended in the survey report.

OBSERVATIONS ON FACTORS DETERMINING SUCCESS IN PHYSICS.

By Archer W. Hurd

North High School, Minneapolis, Minn.

(Continued from the February issue)*

VI.

Interesting facts are revealed in Chart IV. This shows the S. D. rating of 98 pupils in the Otis test, the Miller test, the two tests combined (Mean), the total scores in the tests in Physics, and the Achievement Quotient of each pupil. Individual differences are manifest as well as some interesting deviations between capacity ratings and achievement in Physics. Such a table should prove useful in aiding a teacher in giving marks at the end of a semester. It shows that many students are doing better work than might be expected, others are about living up to their capacities, and many are falling below expectations. Of the first mentioned, Numbers 2 and 107 are the most conspicuous examples. Both of these have apparently eclipsed their classmates in the effort put upon the work. Both are rather slow, however, 2 being a very careful, painstaking boy. He is one of the two best boys in Mechanical Drawing. The showing of Number 51 is also worth noting. He is an especially hard worker, this being recognized by the presentation to him last year of a silver loving cup by the Hi Y boys for distinction in school work. Number 8 warrants notice also. He is the lowest in intelligence rating and not very much better in the tests in Physics, but he does very fine work in Mechanical Drawing. He, with Number 2, are the best boys in the drawing class, both doing beautiful work.

Numbers 10, 28, 39, 50, 65, 68, 72, 78, 105, 106, and 112 are examples of similar ratings in the tests in Physics and in intelligence. They are apparently living up to their relative capacities in the group as well as could be expected. Numbers 12, 35, 54, 76, 97, 100, 101, on the other hand, are not living up

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In the February issue the legends in connection with the three cuts are not clear. Figure I is: "Comparisan of Scores in Miller and Otis Tests." Figure II: "Comparison I and Q's, Otis and Miller Tests." Figure III: "To Show S. D. Rating in the Total Scores in Physics Tests." M=91.6, S. D.=21.75. Also Figure I should be turned so that if the two lines were continued they would intersect near the lower left hand corner.

CHART IV.

S. D. RATINGS, OTIS, MILLER, TOTAL or MEAN of the OTIS and MILLER, TOTAL SCORES in PHYSICS TESTS, and ACHIEVEMENT QUOTIENTS

PUPIL	MILLER	OTIS	BOTH	PHYSICS	A. Q.	PUPIL	MILLER	OTIS	BOTH	PHYSICS	A. Q.
1	51.5	62.1	56.8	62	109	63	59.0	47.3	53.1	50.1	94
2	31.3	31.8	31.5	54.2	172	64	54.6	44.0	49.3	43.8	89
4*	59.8	71.1	65.4	58	89	65	47.0	48.4	47.7	48	101
5	30.9	46.2	38.5	28.8	75	66	59.0	55.2	57.1	51.6	92
6	66.1	63.2	64.6	61	94	67	36.8	48.4	42.6	49.3	116
7	48.7	48.4	48.5	41	85	68	48.7	48.4	48.5	49.3	102
8	21.1	28.1	24.6	28.3	115	70	53.0	39.4	46.2	34.2	74
10	56.8	61.0	58.9	60.6	103	72	61.1	61.0	61	59.8	98
11	48.7	51.0	49.8	56.2	113	74	47	44	45.5	39.2	87
12	42.0	41.8	41.9	29.6	71	75	45	42.8	43.9	38.8	88
13	56.8	70.0	63.4	63.2	100	76	50.4	55.2	57.8	43.3	75
14	54.6	40.7	47.6	40.5	85	77	51.5	56.5	54	62.4	116
15	45.8	46.2	46	51.1	111	78	36	33.8	34.9	34.8	100
16	31.3	38.1	34.7	30	86	79	44.2	36	40.1	35.7	89
17	50.9	57.7	54.3	58	107	80	47	46.2	46.6	42	90
18	45	42.8	43.9	37.9	86	81	60	62.1	61	58.8	95
19	48.0	54.1	51	59.8	117	82	36.8	45	40.9	46	112
20	58.2	48.4	53.3	49.7	93	83	60	47.3	53.6	37.4	70
22	50.9	27.0	38.9	41.0	105	90	58.2	65.3	61.7	53.2	86
24	45.8	47.3	46.5	49.7	107	91	49.4	53	51.2	37.5	73
25	39.0	46.2	42.6	50.2	118	92	60	55.2	57.6	42	73
26	30.9	28.3	29.6	37.0	125	93	45	41.8	43.4	46.7	108
28	52.2	58.9	55.5	55.7	100	94	33.8	42.8	38.3	32.5	85
30	53.0	47.3	50.1	39.8	79	95	37.5	47.3	42.4	45.1	106
31	35.2	30.4	32.8	36	110	96	51.5	46.2	48.8	51.1	105
32	50.1	41.8	45.9	51.1	111	97	53.8	49.7	51.7	41	79
33	48.0	44.0	46	38.8	84	98	45	49.7	47.3	36.5	77
34	51.5	48.4	49.9	45.6	91	99	68.3	63.2	65.7	62.4	95
35	66.1	58.9	62.5	49.7	80	100	52.2	46.2	49.2	33	67
36	66.1	63.2	64.6	67	104	101	62.7	52	57.3	44.1	77
37	44.2	48.4	46.3	44.2	95	102	38.2	34.8	36.5	40.5	111
38	65.6	66.8	66.2	70.1	106	104	45.8	42.8	44.3	37.9	86
39	50.9	46.2	48.5	48.8	101	105	48	40.7	44.3	44.1	100
40	41.2	44.0	42.6	46	108	106	57.6	61.0	59.3	61	103
42	48.7	56.5	51.1	53.3	104	107	39	33.8	36.4	52	143
43	54.6	64.3	59.4	68.8	116	108	71.2	71.1	71.1	67	94
44	42.0	41.8	41.9	29.2	70	109	59.0	60.0	59.5	62.4	104
45	61.1	58.9	60	50.1	84	111	44.2	41.8	43	55.8	130
46	56.0	56.5	56.2	53.3	95	112	54.6	54.1	54.3	53.8	99
48	62.0	64.3	63.1	54.8	87	113	36.8	44.0	40.4	55.6	138
50	30.0	42.8	36.4	37.4	103	114	32.2	38.1	35.1	34.8	99
51	48.7	58.9	53.8	61.5	114	115	55.2	53	54.1	43.2	80
54	59	60	59.5	44.7	75	116	51.5	48.4	49.9	46	92
55	37.5	51.0	44.2	36.6	83	117	40.6	48.4	44.5	48.8	110
60	66.1	61.0	63.5	58.3	92	118	54.6	53	53.8	53	99
61	53.8	45.0	49.4	58.3	118	121	31.3	37.1	34.2	39.2	115
62	48.7	45.0	46.8	55.2	118						
											Avg. 98

to expectations. In some case, there are good reasons. For example, 76 is a girl who does beautiful work, always has lessons well prepared, writes up laboratory problems in superior shape, and does much extra work, but never writes a good test in any

subject. Number 35 apparently doesn't work very hard but relies on his native ability to get him through his work. He talks well and is a quick thinker, but shows a lack of time spent in preparation. Number 100 is a girl who is pretty, a nice girl, but apparently a very sociable being whose mind is more on her looks, boys, and parties than on Physics. Hence, she lacks powers of concentration, which will need serious efforts to eradicate. These are merely illustrations of the use of the table.

It might be well to add that the pupils themselves are very much interested in tables of this kind. They like to know how their marks are made up and in what respects they do not do as they should. They like the objectivity and impartiality of the whole scheme and seem to really see, as they had not from any other method, their actual place in the group and how it may be bettered. The effects of industry are made very clear and effort is thereby stimulated. Some of the lowest in intelligence rating are already the hardest workers and they should certainly receive due recognition in some way.

VII.

An interesting consideration in this study is the question of the relation of intelligence quotients to success in the Physics tests. In order to investigate this phase, it must be known that the Mean of intelligence quotients computed from the Miller and Otis tests respectively was 120.28 for 98 pupils. The intelligence quotients of all those pupils having 40% of the questions in Physics correct, namely, a total score of 57.6 out of a possible 144 points, were compared with the Mean. Those below this score (57.6) are listed with their scores:

Pupil	I. Q.	Score in Physics
8	89	45
5	104	45
44	114.5	46
12	109.5	47
16	100.5	48
94	107	53
100	118.5	54

All of these are below the Mean of the intelligence quotients. Number 44 is a boy who moved to Minneapolis this year. Apparently, he has had poor training in his previous school work, for his work is consistently poor, though his intelligence quotient is such as to lead one to expect him to do better. Number 100 is the girl, mentioned previously, who lacks interest because of so many social diversions. A further study of low scores above

57.6 reveals the following:

Pupil	I. Q.	Score in Physics
26	95.5	63
31	99	61
121	100.5	68
114	100.5	58
50	101	64
78	103	58
102	103.5	71
79	108.5	60

The low scores are almost universally obtained by those having low intelligence quotients. Number 2 is, as noted previously, a notable exception.

A study of high scores, on the other hand, indicates that on the whole those of high intelligence quotients make high marks. Those receiving scores of 119 or above in the tests in Physics are as follows:

Pupil	I. Q.	Score in Physics
38	139	136
43	136	133
108	146	129
36	142	129
13	128	121
99	138	119
109	134	119
77	122	119

The correlation between the intelligence quotients, as computed, and the scores in the tests in Physics was found to be .759+.03, which shows that the intelligence quotient will serve as a good index of success in Physics. As inspiration rather than coercion is resorted to by the writer in trying to get the pupils in his classes to do worth while things, the intelligence quotient is also a fairly reliable indication of interest in the subject of Physics; for the work of Number 2 and others show that good marks can often be obtained if only enough effort is put into the work, and the results obtained by Number 52 (I. Q. 133.5—Physics 77) and by several others show that the intelligence quotient alone will not bring success in Physics. Interest begets effort and effort begets success. A complete table showing the intelligence quotients and scores in Physics for 94 pupils is shown in Chart V.

VIII.

Another pertinent question, the inquiry of which is well worth while, is that of actual accomplishment in the subject

CHART V.

TABLE to SHOW the RELATION BETWEEN INTELLIGENCE QUOTIENT and SCORE in PHYSICS

Pupil	Mean I. Q.	Total Physics score	Pupil	Mean I. Q.	Total Physics score
1	128	118	64	119.5	78
2	97.5	101	65	115	87
4	140.5	109	66	129	95
5	104	45	67	109.5	90
6	138	116	68	126	90
7	117	72	70	119.5	57
8	89	44	72	132	113
10	127.5	115	74	118	68
11	120.5	105	75	111.5	67
12	109.5	47	76	135	77
13	128.5	121	77	122	119
14	108.5	71	78	101.5	58
15	114.5	94	79	108.5	60
16	100.5	48	80	118	74
17	126	109	81	142	111
19	121.5	113	82	109.5	83
20	123	91	83	131	64
22	110	72	90	132	99
24	114.5	91	91	120	64
25	110	92	92	128	74
26	95.5	63	93	110	84
28	124	104	94	107	53
30	122.5	69	95	108.5	81
31	99	61	96	119	94
32	115.5	94	97	126	72
33	117	67	98	118	62
34	119.5	82	99	138.5	119
35	136.5	91	100	118.5	54
36	140	129	101	133.5	79
37	114.5	79	102	103.5	71
38	139	136	104	113.5	65
39	117	89	105	112.5	79
40	110	83	106	126.5	116
42	123	99	107	103.5	96
43	136.5	133	108	146	129
44	144.5	46	109	134	119
45	129.5	92	111	130.5	104
46	125.5	99	112	124	100
48	137.5	102	113	107.5	82
50	101	64	114	100.5	58
51	125.5	117	115	124	77
52	133.5	77	116	118.5	83
54	129.5	80	117	115.5	89
55	110	62	118	123.5	98
60	137.5	110	121	100.5	68
61	126.5	110	18	112	65
62	119.5	103			
63	128.5	92	MEAN	120.28	

matter of Physics as it is now understood by teachers of Physics and authors of text books. Are the pupils who are studying Physics actually getting subject matter information and are they actually gaining the ability to solve the ordinary problems, the solution of which indicates the possession of the necessary information?

This may be partially answered by inquiry into the scores obtained in the Physics tests. In order that valid judgments may be made, the manner of making up the questions in the tests must be understood. While the writer had in mind the construction of a measuring instrument which would measure subject matter information and ability to solve problems, no points have been touched upon in the tests which are not discussed in practically every text book bearing upon the subject of Physics. Novel questions or questions dealing with information not included in all of the modern text books were omitted purposely. Also, no questions were made difficult purposely so that few would be able to answer them. No points were included but those that in his opinion should be answered correctly by any capable student who had really applied a fair degree of effort in his attempts to get the assigned work. Furthermore, for several years after the writer began the teaching of Physics, it was his fixed opinion that a pupil should not be given a passing mark unless he were able to answer at least 75% of a similar group of questions correctly. It is still his opinion that a pupil doesn't know *much about Physics* if he is unable to answer at least 70 or 75% of such a series of questions correctly. No questions are asked that haven't been assigned in some lesson, and either discussed in class, especially explained by the teacher, or opportunity given to those who did not understand, to ask about.

Moreover, as mentioned before, all are based on the outline of Physics prepared by the Minneapolis Physics teachers. They undoubtedly embrace standard conceptions of subject matter held by the great majority of teachers of Physics.

The highest possible score is 144. The scores for 86 pupils in the writer's classes range from 44 to 133, the arithmetic Mean being 88.4. On an old-fashioned percentage basis, this means that the average standing of the class was 61%, that 17 of the group obtained a standing of less than 75%, that 22 obtained a standing of less than 50%. If the promotion had depended on old time standards, which still prevail in many schools, with 75% as the passing mark, 69 out of 83 would have failed; only 17 would have passed.

Perhaps the writer has placed himself in a position deserving severe criticism as a teacher of Physics. He has not been able to teach his pupils the subject matter of Physics as he would like to have done. He admits the failure and yet record shows

that every pupil received a passing mark. What excuses has he to offer?

It may be well to reiterate at this point the fact that some of these tests have already been given in the Minneapolis high schools and that the scores obtained by pupils in these various schools are quite similar to those obtained by the writer's pupils, there being cases of lower averages in some classes and higher in others. The probabilities are that not much different results would be obtained if other pupils in many other high schools were exposed to the same tests, (which will be done.) Hence, the writer feels that probably other teachers of Physics are in a similar position with regard to failure in teaching well recognized subject matter. Probably not many would object if the statement were made that very few teachers are succeeding in really teaching the subject matter of their subjects according to old-fashioned standards of accomplishment. Pupils are not really accomplishing what teachers think they should as regards subject matter information in any of our secondary school subjects, even the most practical ones. Why not? What excuses may be offered? (The writer takes it for granted that no long discussions in the way of argument, are necessary for general acceptance of the above stated failure to teach our subjects.)

In the first place, there is no evidence to prove absolutely that teachers ever have taught their subjects more efficiently than now. All evidence, on the contrary, is in favor of present-day teaching methods. As far as results are concerned, the probability of a larger percentage of high capacity pupils in former days is greater on account of the fact that education was sought by those who desired it. Today, compulsory education laws enforce attendance at school so that more or less automatic selection of pupils with high capacities, by elective school attendance is not taking place. The actual average mental capacity of the pupils in a modern high school is probably lower than that of three or four decades ago. Hence the task of teaching today is a more difficult task. Lower capacity makes more effort necessary and hence more stimulation of interest and better methods of presentation in order to produce equal results. In addition, the complete comprehension of the subject matter covered in some of our high school subjects is probably beyond certain types of capacity now found among the student body. The relationship shown between Intelligence

Quotients and success in Physics is evidence in support of the truth of the last statement.

Changing conceptions of education also influence the actions of teachers today. With compulsory education laws, have teachers the right to hold every student up to a high standard of proficiency in every subject? With four regular subjects a necessary part of each student's program in most schools besides Gymnasium, Chorus, and extra curricular activities, time needed for daily exercise, recreation and the proper amount of sleep, should high achievements in all subjects be expected? What is education for? Is a pupil a vessel to be pumped full of learning? Are the courses to be considered merely as opportunities for the pupil to get acquainted with different types of subject matter? Is no hard work to be expected of a student? Doesn't a diploma from a high school mean anything concerning absolute achievement? Can't employers place any dependence on the meaning of graduation from a high school? Do high schools marks mean something or nothing? Are worthy character traits to be developed in high school? Is the choice of a life vocation part of the function of a high school? How are worthy means of spending leisure time to be inculcated? Shouldn't a pupil learn in high school how to care for his health and that of others, and how to carry his share of the burdens in his home and community? Is a teacher justified in failing any pupil who has done his best? Must each pupil follow the same beaten path in any given subject? The answers to these questions must be found before the teachers are condemned for not bringing about greater degrees of attainment in acquisition of pure subject matter information. Modern conceptions of education are concerned about these kinds of problems.

UNITED STATES LEADS WORLD IN CHEMICAL RESEARCH.

Leadership in chemical research, captured from Germany during the World War, is still held by scientists in this country, figures compiled for the Journal of Industrial and Engineering Chemistry by Prof. E. J. Crane of Ohio State University show.

Germany, France, and Belgium have come back strong; but have not yet regained their pre-war productivity. Austria and Russia have been slower in recovering from the setback. British chemists have maintained a steady productivity and made a slight gain, while Japan is becoming an increasingly important country in chemical investigation.

Czecho Slovakia, Poland, Roumania, and China, have recently taken a place among the producers of chemical research?

Prof. Crane's figures are based on the number of articles appearing in chemical journals of the various countries. In 1913 the German journals published 6,512 chemical articles and the American 3,940. In 1923 the relation was reversed; the American journals publishing 6,014 and the German 5,064.—[*Science Service*.

THE VALUE OF THE VERBAL PROBLEM[1]

By Dr. J. M. Kinney,
Crane Junior College, Chicago

The verbal problem as usually considered consists of a statement expressed in words concerning certain related quantitative facts. The purpose of the proposer is to have the solver marshall these facts and express their relationship by means of an equation, or set of equations, which is to be solved.

It is my task to point out what value, if any, verbal problems may have. These problems originated in ancient times as the heap problem of Ahmes and the epitaph of Diophantus bear witness. At first they seem to have been proposed as puzzles having no serious purpose. In recent times, however, teachers of algebra employ them to give what they believe to be genuine mathematical training.

Among some of the reasons given for their employment are the following:

(1). *To give a concrete application of an abstract theory.* Thus: in most algebras we find after a treatment of a particular kind of an equation a set of problems giving rise to this equation. This is a legitimate reason. One of the chief reasons, I think, for studying mathematics is to get an insight into the uses of mathematics in developing our civilization. As Prof. Nunn[2] has so well stated, "A person to be really 'educated' should have been taught the importance of mathematics as an instrument of material conquests and of social organization." These things verbal problems, provided they are of the right sort, will no doubt help to accomplish.

(2). *To develop the ability to translate a quantitative relationship, expressed in words, into the symbolic language of algebra.* Mathematics could not have developed into the great system it is had it not been for the development of a symbolism. The pupil gains, through practice in translating, an appreciation of this fact and of the fact that mathematical language is a great economizer of time.

(3). *To develop the ability to think.* Of course to solve any problem is to think. And, no doubt, most of us feel that practice in thinking improves the ability to think.

[1] Read before the Central Association of Science and Mathematics Teachers meeting at Chicago November 28, 1924.
[2] The Teaching of Algebra, p. 17.

(4). *To develope the ability to solve the problems of a quantitative nature that may rise in the various fields of human endeavor.* In this connection verbal problems may be useful provided they are of the right sort.

My qualification requires me to point out what verbal problems I believe to be of the right sort. As a general statement I should say that a verbal problem, as well as any other problem, should raise a genuine mathematical question. In order to get the matter before us in a concrete form I append three exhibits of verbal problems.

EXHIBIT A

1. The combined horse power of a Mallet compound freight engine (Erie R. R.), of a Pacific passenger engine (Pennsylvania R. R.) and of a Baltimore and Ohio electric tractor is 11,200. The horse power of the freight engine is 1800 more than that of the electric tractor and 1000 less than that of the passenger engine. Find the horse power of each.

2. A tennis court, for four players, is 6 feet longer than twice its breadth. The perimeter of the court is 228 feet. Find the dimensions of the court.

3. B has twice as much money as A. The square of the number of dollars of B's money diminished by the cube of the number of dollars of A's money is equal to the excess of four times the square of the number of dollars of A's money over 125. Find the number of dollars possessed by each.

4. John and Henry together have 18 marbles. The square of the number of John's marbles diminished by 12 times in sin 30° is equal to the square of the number of Henry's marbles diminished by 19 times the product of the number of John's marbles and tan 45°. Find the number of marbles each owns.

Now such problems seem to me to be ridiculous. But some one may argue that the pupil in solving them improves his ability to translate ordinary language into an equation. Maybe he does. But is he not done more harm than good by getting a mistaken notion as to the function of mathematics. Every one of these problems is characterized by the fact that the proposer knows the answer. In constructing the problem he works out from the an-

swer. His statements of relationships are based on the known solution. In a genuine mathematical problem the investigator starts with certain known relations from which he secures additional information. Verbal problems should be of the same character. Exhibit B gives some examples.

EXHIBIT B

1. Bell metal is an alloy of copper and tin. In this alloy there is four times as much copper as tin. How many pounds of each element are there in a bell weighing 25 pounds?

2. A milk dealer wished to make cream containing 20 per cent butter fat from milk and cream testing 4 per cent and 25 per cent butter fat respectively. How many gallons of each of the latter should he take to make 30 gallons of the former?

3. Two rubber cords are suspended from a horizontal support. One is 18 inches long and is stretched $1\frac{3}{8}$ inches by each additional ounce weight hung at the end. The second is 21 inches long and is stretched 7/16 inch by each additional ounce weight added. What weight will stretch them to the same length and what will that length be?

These problems raise genuine questions. The pupil who solves such as these comes to realize that mathematics is a useful instrument of investigation. However, these problems were framed for the purpose of securing a particular numerical solution. A much more valuable type is one which gives rise to a general solution and displays the relationship existing between the variables. Such a type is found in Exhibit C.

EXHIBIT C

I. A tank which has a capacity of 100 gallons is being filled at the rate of 4 gallons per minute. At a certain instant it contains 40 gallons of water.

1. If time is counted from this instant, what formula would give the relation between the time, past or future, and the number of gallons of water?

2. Construct a graph which also gives the relation between the time and the number of gallons.

3. From the graph find

(a) the number of gallons after 2 min.; $4\frac{1}{2}$ min.

(b) the number of gallons 2 min. ago; $3\frac{1}{2}$ min. ago; 12 min. ago.

(c) the time if the number of gallons is 70; 24; 0.

4. Obtain the information requested in (3) by means of the formula. Do your results agree with those of (3)?

5. If the time during which the tank is being filled is counted from the instant it begins to fill, where should the g-axis be placed? Would the formula be changed? If so, what would it be?

6. Suppose the time is counted from the instant the tank is half full. Where should the g-axis be placed? What should be the new formula?

7. Can the graph extend below the g-axis?

II. The pressure of the wind on a given plane surface varies as the square of the velocity of the wind.

1. Translate.

2. If the pressure on a bill-board is 54 pounds when the velocity of the wind is 6 miles per hour, what will it be when the velocity of the wind is 12 miles per hour?

3. Find the ratio of the pressure of the 12-mile wind to that of the 6-mile wind. How is this ratio related to the ratio of 12 to 6?

4. Make a table of velocities and corresponding pressures for velocities 6, 12, 18,............60 miles per hour.

5. From your table find the ratio between any two velocities and the ratio of the corresponding pressures. How is the latter ratio related to the former? Answer the same question for other pairs of ratios. What is your conclusion?

A NEW HONOR FOR JOHN MERLE COULTER, HEAD OF THE DEPARTMENT OF BOTANY AT THE UNIVERSITY OF CHICAGO.

Professor John Merle Coulter, Head of the Department of Botany at the University of Chicago, received the honorary degree of Doctor of Science at the June commencement of Lake Forest University. Professor Coulter, who recently returned from a six months' absence in China and Japan where he lectured before colleges and universities on evolution and the relation of science and religion, has been president of Indiana and Lake Forest Universities, as well as president of the American Association for the Advancement of Science, the Botanical Society of America and the American Association of University Professors. He is the author of numerous authoritative books in the botanical field, including *Evolution of Sex in Plants* and *Plant Genetics*, and is joint author with his son, Merle C. Coulter, of a new volume on *Where Evolution and Religion Meet.*

ALGEBRA IN THE JUNIOR HIGH SCHOOL[1].

BY E. C. HINKLE,
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When arithmetic first became a school subject for young children the content and the method of teaching the subject were the content and method previously used by the learning adult. Ever since Pestalozzi demonstrated in his teaching that children did not and could not intelligently learn arithmetic as the mature adult learned it, teachers in the elementary school have been searching and experimenting to find the best methods of teaching the subject. The change has been slow but sure. The teaching of geometry has had a similar but slower change. Geometry was first built up to suit the mature mind. In this form it was introduced into the college, then into the secondary schools with very little change of content and method. It is only within recent years that the subject has been noticeably simplified to conform with the thinking of high school pupils. But geometry has much further to go in the process of reconstruction than any other subject in high school mathematics before it will be above criticism as a subject entirely adequate for high school pupils.

Algebra has also had a very slow adjustment. The content of the subject and the method of teaching it were at first adapted to the mental level of the mature scholar, then introduced into the college, then transplanted to the academy, and later to the public high school with very slight simplification. Some of us can remember the popular high school algebras of twenty-five or more years ago. Those high school algebras contained material almost difficult enough for a college algebra of today. About fifteen years ago algebra was introduced into the eighth grade of many elementary school systems in this country. The content and the method of teaching this eighth grade algebra were almost precisely the content and the method of teaching first year high school algebra at that time. Teachers soon realized the harm being done to both the pupils and the subject by inflicting upon eighth grade pupils the traditional algebra of the high school and as a result the subject was dropped from the eighth grade cur-

[1] Read before the Central Association of Science and Mathematics Teachers, November 28, 1924.

riculm, leaving arithmetic as the only type of mathematics in the upper grades of the elementary school for several years. Then for many reasons there began a movement to reorganize and reconstruct the algebra of the ninth grade and the geometry of the tenth grade and to correlate the three subjects of arithmetic, algebra, and the elements of intuitive, constructional, and demonstrative geometry into a continuous course of mathematics for the seventh, eighth, and ninth grades with the three subjects progressing either simultaneously or alternately by chapters. At first the movement to reorganize high school mathematics met with a strong opposition in the form of a natural loyalty to the traditional. It takes only a cursory comparison of the typical ninth grade algebra of fifteen years ago with an up-to-date ninth grade algebra of today to realize the marked improvement of the new over the old, not in thoroughness to be sure, but in the effort to give the boys and girls of our modern senior and junior high schools the type of algebra that is vitalizing and useful although not necessarily always immediately practical.

There are many reasons for this transformation of algebraic content. One is that educational experiments have forced the conclusion that the transfer of training is not pronounced enough to justify including the topics in algebra that have very little application even in the field of pure mathematics. Another is the growing conviction that the methods employed in teaching arithmetic in the lower grades of the elementary school are better adapted to the teaching of beginning algebra in the ninth grade than are the methods formerly used in teaching algebra in the ninth grade. Another reason is the impossibility of achieving satisfactory results in unmodified traditional subject matter under the irresistible pressure of an overcrowded curriculum, with each subject and each school activity making its demands upon the pupils' time, with the numerous extra-school distractions like the movie, the radio, the automobile, and the many forms of social activities requiring their share of time—all a necessary part of this complex modern life—and with all these the many accepted forms of intra-school distractions encroaching more and more every day—all of these diverting influ-

ences together with the handicap of large classes and no indication of smaller classes in the near future. It is a wonder that the pupils learn as much as they do; they do pretty well after all. Algebra is not behind in shaping itself to harmonize with these modern conditions.

Whether we like it or not, it is true that we are allowing the old traditional standard of thoroughness in algebra to disappear and at times it seems that we are gradually becoming reconciled to a lower standard of efficiency in all phases of algebra except in the mere elements. One way to keep optimistic under present conditions is to realize that whereas in former days the pupils were more select and were quite thorough in a few subjects, today pupils although less select and less thorough in the old standard subjects know something about many subjects either unknown or not taught years ago. Another way of making the comparison is to consider the arithmetical product of the number of subjects by the degree of efficiency achieved years ago and the corresponding product today. The degree of efficiency of today suffers in comparison but the number of subjects and activities is outstanding. The arithmetical product of the broad width by the shallow depth of today is perhaps greater than the product of the narrow width by the depth of years ago. Each traditional subject has suffered in depth but in the sacrifice time is shared with the newer subjects and activities now universally accepted as educational. We are learning to make mathematics more educational and more acceptable in the midst of this heterogeneous curriculum all the way from the beginning grades in the elementary school through the senior high school by practicing the following formula: make mathematics simple, make mathematics clear, make mathematics appear easy although it may be difficult, and by all means make mathematics as useful as possible even if it is not always immediately practical.

Since the sum total of a pupil's time for junior high school algebra will never be more than it is right now, in fact it will inevitably grow less little by little, the hope for improvement lies in the more careful choice of usable subject matter, in the selection of a more pedagogical graduation of the topics of algebra, in a more satisfactory

correlation of the subject matter of algebra with arithmetic and the elements of intuitive, constructional and demonstrative geometry, and in a more studied technique of teaching. These are the very directions in which algebra is certainly not behind all other high school subjects, the adverse criticism of our educational friendly enemies to the contrary notwithstanding. But there is still room for improvement, and suggestions are being offered every day, especially by teachers fortunate enough to teach and experiment under controlled conditions along the lines of supervised study recitation, the individual method, the project method, special devices and procedures, or any combination of these methods and procedures with phases of more established methods. It is an undisputed fact that the unmodified traditional type of recitation is far from 100% efficient under the present non-study influences encouraged not a little by the acceptance here and there of the policy of very little home-work, hence the earnest hope everywhere of evolving some plan of getting more work from each pupil during the recitation and school study periods.

The choice of subject matter in junior high school algebra is best studied through an examination of the junior high school texts already in print. There are as yet very few helpful courses of study in junior high school mathematics. Too many cities with junior high schools in full swing continue to report that they are in the process of constructing a course of study. It seems that changes in school organization do not depend upon courses of study. Every city having a junior high school reports the use of some text in junior high school algebra, although in some cases it may be nothing more than some text written for the senior high school. A course of study in junior high school mathematics based on no text in particular and leaving the burden to the teacher of supplying appropriate material from various sources is a beautiful ornament for the teacher's desk but futile as a class room aid to the teacher. Inexperienced teachers cannot successfully follow such a course and experienced teachers will ignore it in favor of some text. There is nothing as helpful to a teacher of algebra as a well-written textbook to be used as a sourcebook for problems and practice material.

There are already in print about a dozen series of texts for junior high school mathematics representing the views and experiences of a score of authors and many more co-operating teachers in all parts of the country. The composite view expressed in these texts is more authoritative than any other views available. A comprehensive, comparative study of these texts would make a master's thesis. It is not strange that there is a difference of opinion among some of the authors along many phases of junior high school mathematics, and it is for the ultimate good of the subjects that there is. An absolute agreement as to what should be taught in the junior high school at the very beginning of the junior high school movement as a permament part of our school organization could hardly be expected. The farther apart these texts are in their material, the sooner it will become more generally known that certain subject matter and methods are not appropriate to junior high school pupils and their methods of learning. The National Committee took practically no stand in the field of junior high school mathematics except the non-committal attitude of suggesting several possibilities and recommending experimentation for further enlightenment. This left the field open and as a result the textbooks are quite diverse in many respects. However they have several features in common.

Practically all texts agree in common that certain topics should be taught in the junior high school, although there is practically no agreement as to the year and semester each topic should be taught; this is because the texts differ as to the organization of the subject matter. These topics in common are: the formula with the simple equation as a tool in the solution of problems, the graph of statistical data, the angle, the metric system, the elements of intuitive and constructional geometry, a little informal demonstrative geometry, the use of tables to compute the side and acute angle of the right triangle with sufficient conditions given (unfortunately called trigonometry by some), and the study of the arithmetic of percentage and the various elementary applications of percentage. The recent arithmetics written expressly for the seventh and eighth grades of the elementary school are also incorporating many of these topics, so great is the tendency to

teach in the seventh and eighth grades a type of mathematics different from that of some years ago.

No text advocates the traditional mastery of every topic before the next topic is introduced. In the lower grades of the elementary school the difficulties of every topic are carefully analyzed, then they are arranged in a teachable sequence, and at the same time the difficulties of each topic are correlated with those of allied topics. This same method of analysis, arrangement and correlation is taking greater hold in the teaching of algebra in both the senior and junior high school. The difficulties of algebra are distributed throughout the three grades of the junior high school instead of being treated for the first and last time in the ninth grade as in the old course. Mathematics is not a subject for sudden mastery. No mastery is attained without time. Skill is an element in the mastery of any phase of mathematics and where skill is essential practice is necessary and this requires time. There is more to a topic in algebra than just its introduction and development by the teacher. The symbolism of mathematics beginning with the simplest forms of computation and the laws of manipulation of this symbolism are complex, technical, mechanical and invariable for each type of difficulty. A reasonable mastery of this symbolism is more than pupils under modern conditions of study can accomplish readily in a short time. We should not wonder why they forget so easily how to add common fractions, how to divide decimals, how to extract the square root, or how to do simple manipulation in algebra a short time after the subject has been studied. It is not so much that they forget the thought phases of the subject as it is that they forget how to manipulate the symbolism in accordance with fixed rules. The same is true in all advanced courses in mathematics. Because of the time that it takes to acquire a control of this symbolism it is highly desirable that every teacher of any phase of mathematics be prepared to help the pupils review such work when it is necessary and it is just as desirable that textbooks provide material suitable for such reviews. This is the reason that the junior high school texts in mathematics devote approximately ten per cent of their space to mere practice material in the arithmetic that has al-

ready been taught in the grades below. For the same reason a college text in algebra is not the best text that does not provide ample review material in topics that have already been taught in the high school. The best teachers and texts see to it that the pupils are confronted at studied intervals with every phase of mathematics previously taught that is worth remembering even temporarily.

Most texts in junior high school mathematics introduce formulas for the purpose of giving the pupils power in evaluation. This evaluation gives the two-fold opportunity of interpretation of symbolism and of arithmetical practice. Some texts introduce the formula without any apparent motivation and without any initial connection with any other phase of the work. Other texts introduce the formula in connection with its natural setting, the statement of the rules of mensuration in their shortest form. In this way the formula appears to the pupils to have a use. In some cases the formula shortens computation and this makes its appeal. There seems to be no excuse in going to the extreme in the evaluation of formulas occurring in physics, mechanics and other later subjects. It is difficult to understand how pupils can be impressed with the significance of such formulas long before they will study the subjects producing these formulas. It should be stated here that many teachers doubt that the pupils gain added control over a subject like simple percentage or simple interest by using the formula. What is gained in solving easy arithmetical problems by using the formula when the same problems are easier by arithmetic? How does the cost formula help to make the simple cost problems clearer? How many teachers of mathematics would solve a simple problem in interest by the formula? How many would solve the following problem by the formula: "How long will it take $480 to yield $86.40 simple interest at 6%?" or the following percentage problem: "A lot costing $400 was sold for $650. What percent of the cost was gained, not allowing for any expenses or taxes?" Should we emphasize with pupils the use of a tool in mathematics in situations where we will not use it ourselves? It seems natural to introduce the formula as a shorthand scheme of stating

mensuration rules to aid in remembering them and as an aid in shortening computation at times and not as a device for solving problems more naturally and more easily solved by arithmetic.

The equation should be introduced as an economical form of stating a problem situation and making the solution easier than the regular arithmetical solution does. It is poor pedagogy to introduce the equation as a mere form and then follow this immediately with the formal axioms used in the solution of the equation. Considerable practice should be given in the solution of appropriate problems that can be solved easier by the equation than by the arithmetical methods. The solution of such simple equations should be done by mere intuition at first. The formal axioms can be used when the solution by intuition becomes rather difficult. This is the way to impress upon the pupils the use of any phase of algebra. In fact the best way to motivate any topic in mathematics is to impress upon the pupils the use and the advantage of the topic. Such motivation is no waste of time.

The attitude of most pupils toward any topic in algebra is formed in the introduction. If this introduction is favorable they will work more willingly. The fact that *we* liked mathematics in our day without any motivation has nothing to do in determining our methods of introducing topics in mathematics nowadays. Pupils are educated today to question the use of a subject before they elect to study it. They are favorably impressed if they can realize what they can do with a subject that they are not able to do without the subject. Right here is where we fail to sell the subject of demonstrative geometry to the average high school pupils. They fail to see even after they have studied the subject that it will ever do them any good, and we are not able to satisfy them that it will ever be of any value to them. This is one of the strongest arguments in favor of correlating algebra and geometry all the way through the course. The subjects will appear to be applications for each other, if no where else. The pupils are more satisfied with this type of application than they are with the common one usually stated in terms of mental power. If we cannot think of a better reason than the mental discipline argument, true

though it is, we should make an attempt to find one and to formulate it clearly, because this reason is failing not only with the pupils but with adults, even with teachers who have had geometry but are now interested in some other line of work. If we cannot sell the subject that we are teaching we should quit teaching it except to pupils who have a natural interest in the subject or to those who must study it in order to go into a line of work that actually makes use of it. Algebra is not so difficult to sell on account of its close relation to arithmetic and its use in the solution of problems.

One of the most practical phases of mathematics beyond simple arithmetic is the ordinary graph. The bar graph, the circle graph, and the line graph are the usual forms. The use of the terms cartograms, pictograms and others grams are unfortunate. Call them pictures, maps, or whatever they are and let it go at that. All junior high school texts give ample attention to statistical graphs, some of them too much attention to the making of graphs and not enough preliminary experience in the reading of graphs. There is a noticeable tendency in some texts to graph relations that are as clear without the graph as with it. What is the gain in graphing the cost relation $c=5n$? The ordinary statistical graph has a significance; it tells so much more in a visual way than the tabular form of the same data, and the pupils can appreciate the advantage of such a graph. There is a real purpose in graphing the simple interest relation and the compound interest relation, viz., to realize the gain of compound interest over simple interest as the time increases. All texts include the graph of the simple equation in two unknows rather early, but just exactly what is gained in such work before taking up advanced algebra? No one solves two simultaneous equations by the graph. Why call it a method of solution when it is not? We should not try to use graphs to exhibit a relation or to find a solution when this relation or solution is more easily found in some other way. There is no question about the value of graphing functions and equations later on but is not graphing the linear equation as a mere stunt out of place in junior high school algebra? Do we not also overwork diagrams in using them to express sums, differ-

ences, products, etc., for example, $a+b+c$, $a-b$, $a(b+c)$, $(a+b)^2$, $(a-b)^2$, $(a+b)(a-b)$, etc.? Because graphs and diagrams are helpful in some phases of algebra is there not a tendency to use them in teaching some phases of algebra where they are of no service and where we ourselves do not use them?

There can be no disagreement about teaching the concept angle and developing a few of the angle facts. Of all the common quantitative concepts like length, area, volume, capacity, weight, time, value, angle, etc., the angle is the only one that can be measured *almost without limit* right on the pupils' desks. Next to length it is the simplest of the space concepts and of course like all the space concepts it aids in correlating arithmetic, algebra and geometry throughout the junior high school course in mathematics.

The worded problem is the most important topic in all algebra. The solution of the worded problem is the best justification for practically all algebraic computation. The four fundamental operations of algebraic expressions, factoring, the solution of the simple equation, the quadratic equation, and simultaneous linear equations, extracting square root, etc., arise in the solution of problems and are easily justified from this standpoint. How can we justify any phase of algebra that does not arise in the solution of algebraic problems? Some teachers prefer to regard the *equation* and others the *function* as the connecting thread of all algebra and the source of all algebraic computation. But the solution of the algebraic problem is the only justification for the different types of algebraic manipulation in the junior high school. If these problems are kept within the ability of the pupils the result is a simplified algebra that we can defend against all odds. What more can we ask of our pupils than the power to translate worded problems into algebraic language and the ability to solve the equations arising from such translation? It is not the function nor the equation that keeps algebra alive; it is the algebraic problem. Why do we teach arithmetical processes in the elementary school? Is it not for the sole purpose of enabling the pupils to solve practical problem situations in arithmetic? All phases of arithmetical computation that have

no application in the solution of practical problems are rapidly being eliminated from the course and those processes that remain are being simplified on the grounds that complicated forms do not occur in practical problems. The same tendency is operating in the simplification of the algebraic processes. This is the reason that all new texts in algebra stress the care with which their problem material is selected and experimentally tested. It is their best selling point. The authors of the best texts see to it that the problem plays its part in the motivation of every algebraic topic.

We are being severely criticized for including types of problems not wholly practical. We must offer a defense for these problems or forever eliminate them from the course. Certain types of these problems have their place in algebra. There are no better problems to be found for the purpose of giving practice in translating worded mathematical situations into algebraic language. Such problems as the simpler age problems, number problems, perimeter and area problems, coin problems, angle-sum problems have no equal in this type of work. Many of the so-called practical problems at this stage of algebra are too involved with technical terms and conditions to be of any service when mere translation and solution of the resulting equation are the object. The elements of physics, mechanics, investments, etc., make beginning algebra top-heavy with technicalities. A certain mathematical power must be acquired before technical situations can be studied with profit. The following problem should please our critics. It is not artificial; it is practical; it arose in a real situation; and it is not an answer-known problem. "The paving assessment against a corner lot 125 feet deep and fronting 49 feet is $1411 to the middle of the street all along the front and side of the lot. For the side street the assessment is 40% of the total assessment to the center of the street and for the front the entire assessment to the center of the street. What is the assessment per front foot for the paving to the center of the street?" The owner of the lot wanted this problem solved so that he could use the result as a talking point in getting the assessment reduced. Its solution leads to the very simple equation $.40(125x)+49x=1411$, which a

pupil not half way through ninth grade should be able to solve and yet how many pupils in advanced senior high school algebra will translate the problem into its equation? It is typical of most of the practical problems heavily laden with technical language and situations unfamiliar to the pupils. Hence the need of a simpler type of problem preliminary to this more difficult type. This simpler type must be algebraic but unencumbered with technicalities. Such is the function of the simple age problems, number problems, perimeter and area problems, coin problems, angle-sum problems, etc. The working problems, tank problems, digit problems, clock problems, and rate and distant problems beyond the very simplest should be used with extreme caution if at all. Let us hold on to these very simple problems even if they are not practical from a commercial and social standpoint. They are the most useful problems for a preparatory type of work; they furnish just the very kind of practice that the pupils are ready for, and they are the best preparation for the more practical but more difficult problems.

There is no genuine objection to the answer-known problems. The other kind involves computational difficulties that the pupils are not ready to meet at first. There is also no valid argument against requiring pupils to be able to perform algebraic manipulations a little more difficult than those required to solve problems, but the reason for asking them to do such work is that similar manipulation arises in connection with the solution of problems and that skill in algebraic processes, as in arithmetical processes, is more easily acquired by practicing on types of exercises similar to but more difficult than those arising in the solution of worded problems. For example, skill in factoring a trinomial quadratic is not very trustworthy if this skill is acquired by practicing on exercises no more difficult than those arising in the solution of appropriate problems producing quadratic equations to be solved by factoring.

There is another phase of junior high school mathematics called indirect measurement, which belongs more to the discussion of the subject of geometry than to this dis-

cussion. In general indirect measurement means the determination of the amount of any quantity by any other means than counting by ones or by the direct application of a unit of measure to the quantity measured. All the processes of computation in arithmetic and algebra and all the rules for determining results in arithmetic and algebra are but means in indirect measurement. Indirect measurement as applied to length means determining the length of a line-segment in any other way than by measuring it directly with a unit of measure or a tape line. Such determination can make use of scale drawing, similar triangles, square root, and right triangle ratios of sides (trigonometric ratios). Pupils should realize without unnecessary practice that determining lengths of line-segments by scale drawing and the use of similar triangles as treated in the arithmetics and junior high school texts is crude and hence very inaccurate, hence the need of such more reliable means as square root and the right triangle ratios of sides. Some texts over-emphasize the use of scale drawing and similar triangles in indirect measurement. Occasionally we find a text advocating the trial division method of extracting the square root of numbers. It is difficult to conceive of anything in mathematics more ridiculous and less mathematical than the laborious trial division method of extracting square root. The argument usually given in its favor is trivial.

There is an unwarranted prejudice in some minds against introducing the trigonometric ratios and tables of computation in the junior high school. This prejudice is due largely to ignorance. When this phase of work is made simple, clear, and easy the pupils enjoy using the ratio tables in determining an unknown side or an unknown angle of a right triangle. Such work is mere arithmetic, and it gives the pupils an initial introduction to an interesting and practical phase of mathematics. Perhaps if the trigonometric terms could be replaced by simpler terminology at first there would be no objection to this elementary type of indirect measurement. Inexperienced teachers are likely to confuse the pupils in placing too much emphasis on terminology. The mere mention of the terms sine, cosine and tangent is enough to arouse the opposition of those critics who know nothing about the

subject and of those who have forgotten everything about the subject except their aversion toward it due, no doubt, to poor instruction or their attempt to cover the entire subject in ten or twelve weeks in the university. The mere name trigonometry or the terms sine, cosine and tangent suggest to many a critic the entire subject of trigonometry, just as the word function suggests to some the whole subject of the theory of functions. Beyond the field of arithmetic the subject of trigonometry is one of the most practical subjects in all mathematics, and it is an enjoyable subject if it is taught properly. The mere elements of the subject in connection with the right triangle can be taught with profit in the junior high school in the ninth grade as a phase of indirect measurement, if a capable teacher is doing the teaching.

A few extreme tendencies in some of the junior high school texts have already been mentioned. Attention should be called to a few others. One text includes a chapter on logarithms in the eighth grade. Any one who is thoroughly acquainted with pupils of junior high school age by and large must know that this subject is out of place in the mathematics course of the junior high school, especially below the ninth grade. Another text devotes a chapter to the slide rule. We must not let our enthusiasm in any one direction in the mathematical realm darken our outlook over the general field of mathematics suited for the junior high school. Pupils of the junior high school are mere children and have about as much need for a knowledge of the workings of the slide rule as pupils in the second grade of the elementary school have for a knowledge of the workings of a comptometer. Except to satisfy a spasmodic curiosity of pupils for something novel or except in a class for boys who might possibly be training for a special kind of work in which the slide rule has a frequent use this instrument has no place in the junior high school. Another text defers to the ninth grade the rich field of arithmetic commonly known as applications of percentage, or business practice, and forces into the seventh and eighth grades all the difficulties of algebra and even into the seventh grade the algebra of signed numbers. No matter how well or in what form algebra and geometry are correlated we cannot af-

ford to crowd arithmetic out of the seventh and eighth grades. Arithmetic must be woven into the junior high school course of mathematics in such a way that if any subject suffers it will not be arithmetic. It is not true that at the end of the sixth grade the pupils are tired of arithmetic and are suffering for a change, hence the justification for a change to algebra and geometry. Another author in his treatment of graphs forgets that pupils are not statisticians and he has them graphing the data of different industries involving numbers in the millions. There are numerous applications of graphs immediate to the pupils' interests and these should be used in the junior high school. There are traces of other extreme tendencies in the different texts but they are minor and it is not necessary to mention them here.

The weight of opinion expressed in the majority of junior high school texts in mathematics is in the direction of selecting the best that there is in arithmetic, algebra, and the elements of intuitive, constructional, and demonstrative geometry and weaving them into a continuous course of mathematics useful for all junior high school pupils. We cannot afford to listen without caution to the comparisons already expressed in some localities that the junior high school pupils do not measure up with the other pupils in the advanced course in algebra in the senior high school. If we know that we are right in the course offered in the junior high school the course in advanced algebra will have to adjust itself to the changing conditions. Revision of the curriculum is from below upward, not from above downward. The pupils in the lower grades must have what they need, and if in studying advanced useless topics they are not the equal of the pupils who have studied such topics there is but one thing to do. Reform in mathematics is in the direction of simplification, enrichment, reasonable correlation, and use. After a careful reorganization of the junior high school course in mathematics incorporating these principles and changes, there will be more left than can be satisfactorily taught in the time that will be allotted to the subject.

It will not be entirely out of place in closing to state the aim of teaching mathematics in the junior high school together with the outstanding topics to be included in the

course. The aim of teaching mathematics in the high school is to familiarize the pupils with the mathematical subject matter beyond the first six grades that will be of the most practical value to them as citizens and as students, and at the same time to encourage correct study habits, coherent thinking, correct language, neatness in written work, and an interest in the subject of mathematics—all this to be accomplished in the study of the following topics correlated wherever advantageous:

1. Frequent practice in the fundamental operations with integers, common fractions and decimals in order to attain and to hold a norm of achievement.

2. Percentage and its applications within the experience and comprehension of the pupils.

3. Common space forms and simple relationships arising in line, surface, volume and angle measurement, and the simplest properties of geometrical figures including what is commonly known as intuitive geometry and easy constructional geometry usually deferred to demonstrative geometry.

4. The metric system to include the linear units, the gram and the kilogram, and the liter.

5. The graph for the purpose of visualizing relations and tendencies existing among elementary statistical data.

6. The formula where it helps to abbreviate quantitative statements for the purpose of more easily remembering them and for the purpose of economizing the computation when possible.

7. The equation as an aid in stating quantitative relations and solving for an unknown number.

8. The processes of formal algebra needed in evaluating the formula and in solving the equation.

9. A few easy propositions in demonstrative geometry.

10. Indirect measurement of lines and angles by scale drawing; similar triangles; and the right triangle, making use (a) of the hypotenuse rule and square root and (b) of the sine, cosine, and tangent ratios, and the table of numerical trigonometry for degrees.

CHLORINE FOR COLDS.

By H. C. Kremers,
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A very considerable amount of interest is being shown at the present time in the use of chlorine for colds and allied diseases. In many instance this interest is beginning to crystallize definitely in the appearance of "chlorine clinics," "chlorine chambers," "Coolidge treatments," etc. In every case the method depends upon the fact that a small amount of free chlorine in the atmosphere is beneficial for colds and general infectious diseases of the respiratory passages. It has perhaps been noticed by many chemistry teachers and students as well that exposure to excessive amounts of chlorine, causing rather severe irritation in the throat and nasal passage and even severe pains in the chest, is almost always followed by complete recovery by the following morning. It is now a fairly well established fact that such doses of chlorine act as a very efficient prophylactic and subsequent infection is very much minimized. A general cure for colds has been the mecca of the medical profession for many years. The real discovery, however, of a so-called general cure for colds is again due to the chemist. During the late war it was noticed that the soldiers on duty in the chlorine departments of the arsenals were very much less susceptible to colds than the workers in departments where no chlorine was present. During the severe influenza epidemic of 1918–19 the above soldiers were almost entirely immune. As a result of this observation Charles Baskerville (J. Ind. Eng. Chem. *12*, 293–4) published a digest of correspondence with some twenty-five producers of chlorine. From this data it was found that some thirteen of the largest producers of chlorine reported that among the employees in their chlorine departments there was either an entire lack of infection or most of the cases were very slight. From the several reports of the committee on occupational diseases in the chemical industry (J. Ind. Eng. Chem. *12*, 439–40), (Science *50*, 50 (1919), there is an overwhelming evidence that air containing small amounts of chlorine, bromine or iodine does have a very decided prophylactic effect. Even such gases as sulfur dioxide were favorably reported on. It is also reported by one of the largest producers of bromine in this country, that employees who have worked in the bromine departments for twenty-five years are at the present time in the very best of health and rarely ever out for colds.

In the winters of 1920 and 1923 the University of Arkansas (Harrison Hale. J. Ind. En. Chem. 12, 806 and *15*, 746) placed a chlorine chamber in operation for a few weeks at a time during influenza epidemics. The concentration of chlorine in the room was not constant. By analysis the amount of chlorine varied from .014–.088 milligrams per liter of air. Due to this high average concentration treatments lasted only 5 minutes each day. Some 800 treatments were given to 185 individuals. Only one of these individuals developed influenza during the epidemic which was severe enough to cause the authorities to close the public schools. In the winter of 1923 during a similar epidemic the treatments were again given in much the same way with results almost as favorable.

We are no doubt indebted to Colonel E. B. Vedder, Director of the Medical Research Division of the Chemical Warfare Service at Edgewood Arsenal, for the greatest advances along this line. Most exhaustive researches have been carried out in connection with their chlorine chamber. The limits of chlorine concentration have been carefully worked out on both animals and human subjects. It has been found for instance that .010 milligrams of chlorine per liter of air can be plainly perceived. Concentrations above .017 milligrams per liter will cause irritation of the throat in 10–15 minutes. .015 milligrams per liter of air can be tolerated by most individuals for at least one hour. As a result, this latter maximum practical limit has been selected by Colonel Vedder as most effective for the average individual. Concentrations below .014 have been found to be very much less effective. It is, of course, needless to say that the chlorine chamber at Edgewood Arsenal is equipped with the best ventilating system whereby a constant volume of air is continually admitted to the room. The chlorine gas is admitted into this ventilating system. Samples of air are constantly withdrawn for analysis, and the amount of chlorine admitted, regulated according to analysis.

The chlorine chamber of the Army Research Division in Washington, D. C., under the direction of Colonel Harry L. Gilchrist, M.D., Army Medical Corps, with almost as many cases treated shows an average of 45 per cent cured.

We are especially indebted to Colonel Vedder for the very valuable data that he has obtained at Edgewood Arsenal. The treatments were not only carefully supervised but the actual cures affected were carefully recorded. The following tabulation made by Colonel Vedder follows:

Diseases	No. of Cases	Cured No.	Cured Per Cent	Improved No.	Improved Per Cent	No Change No.	No Change Per cent
Acute bronchitis	241	192	80.0	47	19.5	2	.5
Acute laryngitis and pharyngitis	127	99	78.	24	19.	4	3.1
Coryza (colds)	388	288	74.2	91	23.5	9	2.3
Chronic bronchitis	47	34	72.3	12	25.5	1	2.1
Chronic laryngitis	2	2	100.				
Chronic rhinitis	106	33	31.1	41	38.6	32	30.2
Whooping cough	9	8	88.8	1	11.1		
Influenza	11	9	81.8	2	18.1		
Totals	931	665	71.4	218	23.4	48	5.1

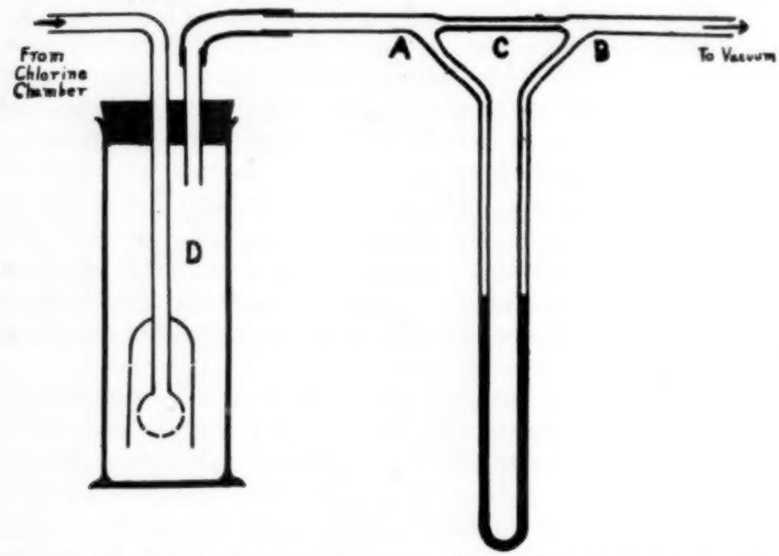
Results from the chlorine chamber of the Navy Dispensary at Washington, D.C., are said to be substantially the same as those obtained by the army doctors at Edgewood and Washington.

From recent press reports Dr. Louis I. Harris from New York City claims that the treatment in New York City was unsatisfactory in the case of some 500 patients. Only 6.5 per cent cured were reported. Colonel Vedder points out that careful regulation of the concentration of the chlorine is as necessary for success as is the necessity of administering an ordinary medicine in definite amounts.

During a recent chemical show held at the Chemical Laboratory, at the University of Illinois, on December 6th such a chlorine chamber was placed in operation. The room selected was an ordinary size class room. The ventilation was supplied in ordinary way from the forced ventilating system of the building. An oscillating electric fan was placed on a shelf directly in front of the fresh air inlet. Chlorine was admitted to the room from an adjacent laboratory, the inlet tube terminating directly back of the electric fan. In this way the chlorine was constantly distributed and kept in circulation throughout the room. An additional electric fan placed at the opposite side of the room was a material aid to circulation. The chlorine was obtained from a cylinder of liquid chlorine and the gas bubbled through a wash bottle to serve as an index for the rate of flow. Air for analysis was continually withdrawn from the room and aspirated through 5 per cent KI solution, by means of a Folin ammonia absorption tube, 50 liters of air being drawn through this solution in 15 minutes. The liberated iodine was titrated with N1100 sodium thiosulfate solution. An analysis was thus made every 15 minutes and the flow of chlorine regulated accordingly. No particular difficulty was experienced in keeping the chlorine concentration within the prescribed limits, even though visitors passed in and

out of the room at frequent intervals. A two hour series of analysis ran as follows:

1:00 P. M.	.0146	milligrams	per	liter	of	air
1:15 "	.0151	"	"	"	"	"
1:30 "	.0153	"	"	"	"	"
1:45 "	.0148	"	"	"	"	"
2:00 "	.0149	"	"	"	"	"
2:15 "	.0146	"	"	"	"	"
2:30 "	.0154	"	"	"	"	"
2:45 "	.0159	"	"	"	"	"
3:00 "	.0150	"	"	"	"	"



The simplest and most inexpensive flow meter to indicate the rate of flow of air to be analysed is that shown in the accompanying diagram. This was constructed according to the flow meters designed by A. F. Benton, (J. Ind. Eng. Chem. 2, 623). The absorption bottle D is shown with the Folin absorption tube in position. Due to the flow of the gases through the capillary C the difference of pressure set up at A and B is indicated by a difference in height of the mercury in the manometer tube. This apparatus was of course previously calibrated.

It is necessary, of course, that several treatments be taken in order to completely cure a cold or to prevent influenza. It is suggested by Col. Vedder that single treatments should not last for more than one hour, depending somewhat, of course, upon the individuals. Several persons took a treatment of one hour during the chemistry show and reported no particular discomfort at the end of the period although a slight irritation of the throat was noticeable.

Science teachers can be of distinct service to communities by installing such chambers as described above. No special equipment is necessary, but it is quite essential that the chlorine concentration be kept up to the amount suggested in this article. Lesser amounts are very much less effective. The question has also been asked by many individuals if the treatment could not be taken at home. It perhaps can be if proper supervision and precautions are taken. It must be remembered that chlorine in the concentrations used is quite corrosive and metal fixtures would soon become badly corroded.

No doubt special devices for taking individual treatments can and will be devised in such a manner that no chlorine escapes into the room. On the other hand a chlorine chamber can be very easily fitted up as a reading room and lounge so that maximum comfort may be had by the individual. An interesting story book or two or a few popular magazines will help to popularize the treatment.

In conclusion it must be urged that if this great cure and preventive is to benefit the public at large as we hope it may, it must be kept out of the hands of the professional quacks, and other mercenary individuals. Already fake nostrums are appearing on the market reputed to contain chlorine. On a community basis the cost of treatment per individual will be less than 5 cents. Some of the professional chlorine clinics are charging at least one dollar per treatment. The community science teacher can make himself of real service by enlisting the cooperation of the various health departments in this benefit to humanity.

NEW KIND OF IMMUNITY DISCOVERED BY CHICAGO SCIENTIST.

A new method of combating disease germs has been discovered by Dr. H. W. Taliaferro, formerly of the Johns Hopkins University and now of the University of Chicago.

When dangerous bacteria invade the human body, the automatic defensive mechanism of the body usually throws fighting units, called antibodies, into the front line trenches of the blood. These protective substances kill the harmful disease organisms.

The new substance found by Dr. Taliaferro is related to such usual antibodies. But instead of wiping out the invading army of germs, it prevents it from perpetuating itself.

Working on a harmless blood parasite of rats, similar to the organism causing tropical sleeping sickness, Dr. Taliaferro found that the parasite, after an initial period of active multiplication apparently lost the power to reproduce its kind. Furthermore, by certain experimental precedure, he found that this peculiar occurrence is due to some substance produced in the rat's blood, and that blood serum containing this substance could be used to stop reproduction of the parasites in new infections.

THE MATHEMATICS INVOLVED IN SOLVING HIGH SCHOOL PHYSICS PROBLEMS.

By G. W. Reagan,
University of Illinois.

There is a difference of opinion among teachers of physics as to the extent to which the quantitative aspects of the subject should be treated in the high school. On the one hand, there are those who maintain that the student has not effectively mastered a law of physics until he understands clearly the mathematical statement of the law and can apply it to a concrete case in the solution of a problem. They contend that it is not sufficient to know that two like magnetic poles repel each other; one must be able to determine with what force a pole of 12 units strength will repel a like pole of 15 units strength when they are 4 cm. apart. On the other hand, some teachers hold that emphasis upon the quantitative treatment of physics will result in discouragement on the part of a great number of the pupils, with a consequent dislike for the subject and a lack of interest in it. They are content if their pupils know that a submerged body is buoyed up with a force equal to the weight of the displaced liquid, even though they may not apply this principle in computing the density of a light solid.

However desirable it may be that the student should make the mathematical application of the laws of physics, the fact remains that in many cases he does not do so with a high degree of success. Three possible explanations of the difficulty occur ~~to the writer~~: (1) The teacher may fail to lead the pupil to a clear comprehension of the laws of physics; (2) the problems which the pupil is asked to solve may in many cases require greater reasoning power than he possesses; or (3) there may be, apart from reasoning power, a lack in the mathematical equipment on the part of the pupil which the author of the textbook presupposes when framing the problem. It is the purpose of this paper to set forth in some detail what this presupposed equipment is in the case of one widely used text and to offer some comments on the curriculum in mathematics as a preparation for the study of physics.

In order to determine what particular items of mathematics are needed in solving high school physics problems, the writer made a study of the problem content of Millikan and Gale's "A First Course in Physics." All the problems, exclusive of the review list in the appendix, which require quantitative treat-

ment and which yield numerical results were solved and the solutions analyzed to determine what knowledge and skills acquired in the study of arithmetic, algebra and geometry are needed in the solution of the problems. No fact, principle or process treated in the body of the text was tabulated. Hence all the items of mathematical knowledge and the various skills tabulated as necessary in the solutions of the problems may be regarded as presupposed equipment of the pupil.

A total of 241 problems were solved and analyzed. A summary of the results of the analysis, classified under the heads of arithmetic, algebra and geometry, follows. It is recognized that in many cases the classification is arbitrary, as, for example, considering the knowledge of the rule for finding the area of a circle as an item of arithmetical equipment, though it might properly be listed under geometry.

ARITHMETIC.

A. *Addition.*—There were 47 cases of addition exclusive of those involving common fractions. In only two cases were there more than two addends and in no case more than three. No addend contained more than five digits. Decimals occurred in 14 of the 47 cases, but mixed numbers did not appear.

B. *Subtraction.*—Excluding common fractions, 37 cases of subtraction were encountered. In 13 of these, decimals were involved; in one case a whole number was subtracted from a mixed number; in all the remaining cases both minuend and subtrahend were whole numbers. The greatest number of digits in any minuend or subtrahend was seven, and in only four cases did the number of digits exceed four.

C. *Multiplication.*—Multiplication was more frequent than all the other fundamental operations combined. It occurred 422 times, exclusive of common fractions. In 137 cases both factors were integers, and in 93 per cent of these cases the multiplicands contained five or fewer digits and the multipliers three or fewer digits. In 89 cases decimals were involved, and in 83 per cent of these the multiplicands and multipliers fell within the limits mentioned. Multiplication by unity occurred 48 times. In six cases one of the factors (but in no case both) was a mixed number. Powers of 10, ranging up to the ninth, were used as multipliers 83 times. Squaring a number occurred 52 times and cubing seven times.

D. *Division.*—This operation was encountered 226 times, exclusive of common fractions. Since it was necessary to annex ciphers to most of the dividends in order to secure the desired

degree of accuracy, no distinction was made between the cases involving decimals and those that did not. The total number of cases of both types was 183. In approximately 75 per cent of these cases the dividends contained five or more digits, while dividends of ten or more digits and divisors of five or more digits were by no means rare. Thirty-eight cases were found in which the divisor was some power of 10, the highest power being the eighth. Division by unity occured five times.

It may be stated here that square root was encountered twelve times, but no case of cube root was found.

E. *Common Fractions.*—Nearly all the operations with common fractions were very simple. Reduction to lowest terms occurred seventeen times. In four cases it was found desirable, though not necessary, to change a common fraction to a decimal. Only three cases of addition occurred, the most difficult being $1/110+1/220$. There were nine cases of subtraction, of which the most difficult was $16/81-16/243$. Fifty-one cases of multiplication were found, in 37 of which one factor was an integer or a mixed decimal. In 23 of the cases one factor was $\frac{1}{2}$, in five cases it was $\frac{1}{3}$, and in five it was $\frac{1}{4}$. Division occurred 17 times.

F. *Denominate Numbers.*—The tables for linear measure and for time were needed frequently. The number of square inches in a square foot was used twice and the number of pounds in a ton once.

G. *Percentage.*—Nine operations involving percentage were performed. Four of these were concerned with finding what per cent one number is of another, two with finding a number when some per cent of it is given, one with the reduction of a per cent to a common fraction, and one with reducing a common fraction to a per cent.

H. *Mensuration.*—Sixteen rules of mensuration were employed in solving the problems, the total number of applications being 46. The figures involved were the circle, square, rectangle, right triangle, cylinder, cube, rectangular solid and sphere. Knowledge of the value of π was needed 19 times.

Algebra.

A. *Translations of laws of physics into mathematical formulas.*—In most cases the statement of the law of physics was accompanied in the text by the mathematical expression of the law. There were, however, nine laws upon which the solutions of problems depended that were not expressed as formulas. It

would seem desirable, if not necessary, for the formula in each case to be constructed as the first step in solving the problem. All these laws involved variation or proportion. The same situation was found in the case of two definitions, viz., the definitions of mechanical advantage and of the index of refraction.

B. *Derivation of formulas from given mathematical relationships.*—There was need of six formulas which were not given in the text, but which were derivable from other formulas that were given or could be obtained from the statements of the laws, as suggested above. To illustrate: From Boyle's law it is known that $P_1/P_2 = D_1/D_2$; from the definition of density, $D_1 = M_1/V$ and $D_2 = M_2/V$ (the volume of the gas remaining constant). Show that $P_1/P_2 = M_1/M_2$.

C. *Solutions of formulas.*—In solving the 241 problems of the text, 56 different formulas were employed, with a total of 177 solutions. In almost every case, all but one of the literal numbers of the formula were replaced with arithmetical numbers and the value of the remaining literal number was then determined. No attempt will be made to classify all the formulas into types. They are quite familiar to all physics teachers and possibly to most, if not all, teachers of algebra. It may be worth while to list a few of the more complicated ones:

$W_1/W_2 = d_2^2/d_1^2$, $P_1V_1/P_2V_2 = T_1/T_2$, $1/f = 1/D_i + 1/D_o$, $C = nE/(R_e + nR_i,)$

$H_1/H_2 = C_1^2R_1/C_2^2R_2$, $V.N_1.1/V.N._2 = l_2\ t_1/l_1\ t_2$.

D. *Solution of equations containing one unknown.*—Eleven linear equations were encountered, of which the three most difficult, perhaps, were:

(a) $20(x-20)\cdot .0568 = 150\ (70-x)$

(b) $300x + 130(80+x) = 25\ [536 + (100-x)]$

(c) $x/1200 + x/1126 = 6$.

The pure quadratic was encountered in the solution of several of the formulas. Only one case of the complete quadratic appeared, and it could not be solved by factoring.

E. *Squaring a binomial.*—This operation was necessary only once, the binomial being $2-x$.

F. *Operations with signed numbers.*—The addition of a negative and a positive number occurred four times, and finding the product of a negative and a positive number occurred five times. There were two cases of subtraction of a negative number from a positive, one case of subtraction of a positive

number from a negative, and one of subtracting a positive number from zero.

GEOMETRY.

The following applications of geometry were made in solving the problems:

1. A right-angled parallelogram is a rectangle.
2. The opposite sides of a parallelogram are equal.
3. Two angles are equal if their sides are parallel, right side to right side and left side to left side.
4. Two right triangles are similar if an acute angle of one equals an acute angle of the other.
5. Corresponding sides of similar triangles are proportional. (In addition to the knowledge of this fact, the ability to form the proportion was, of course, required.)
6. The areas of two circles are to each other as the squares on their diameters.
7. A tangent to a circle is perpendicular to the radius drawn to the point of contact.
8. Two lines in the same plane perpendicular to a third line are parallel.
9. If a line is drawn through two sides of a triangle parallel to the third side, the triangle formed is similar to the given triangle.
10. A right angle contains 90 degrees.
11. The sum of the angles of a triangle equals 180 degrees.
12. The acute angles of a right triangle are complementary.
13. The base angles of an isosceles trapezoid are equal.
14. Lines forming a right angle are perpendicular.
15. If the opposite sides of a quadrilateral are parallel, the figure is a parallelogram.
16. Two triangles are congruent if two angles and the included side of one are equal respectively to two angles and the included side of the other.

Let us consider, in the light of the preceding summary, wherein the student's preparation is most likely to be deficient and what the cause of his deficiency may be.

A study of the summary of arithmetical equipment found necessary would seem to lead to the following conclusions:

1. The addition and subtraction to be performed in solving the problems are quite simple and should give no difficulty, except for a possible occasional error due to human fallibility. Our present curriculum in arithmetic should result in ample skill in these operations.

2. Multiplication and division involving integers and decimals make rather heavy demands upon the student's skill. These operations are frequent and the range in the number of digits and decimal places is large. Considerable proficiency is necessary in division, particularly in the matter of annexing ciphers to the dividend to secure any desired degree of accuracy in the quotient. It is safe to say that many students will not be able to perform these operations with speed and accuracy.

3. There is need for skill in multiplication and division by powers of ten up to the ninth power.

4. Operations with common fractions are concerned with only the simpler types, hence the student should encounter no difficulty here.

5. The knowledge of denominate numbers found necessary is very limited and is probably possessed by all students.

6. The three cases of percentage are found, though the number of occurrences is small.

7. A rather thorough knowledge of the rules of mensuration is needed. Many students meet with difficulty at this point, despite the fact that these rules are encountered in arithmetic and again in geometry.

Omitting algebra for the moment and considering the applications of geometry listed in the summary, one observes that, with a single exception, they are distributed over the first three books of plane geometry as ordinarily organized. It may be stated that the number of problems in which most of the applications of geometry are found is very small. It would seem that the student, provided he has studied plane geometry, should find no great amount of difficulty here. It is recognized, however, that merely possessing a knowledge of the facts listed is not sufficient; the student must be able to see the need for the fact when it occurs and to make the application to the situation. This his training in geometry will doubtless enable him to do in most cases.

Turning to the summary of the needed equipment in algebra, which is expressed in terms of processes and operations to be performed, one is struck by the fact that many of the topics upon which emphasis is placed in the traditional course in algebra either are wholly unmentioned or receive very scant attention. In order to determine with greater precision than could characterize the results of a mere inspection of the applications of algebra just what curriculum would prepare the student

to make the needed applications, the writer analyzed all the operations to be performed into their elements. Then the detailed items were collected and organized into topics which were finally arranged in a somewhat logical order, the result being a curriculum in algebra that should prepare the student for solving the problems in physics.

An illustration of the need for further analysis in determining the curriculum content may be given. One item of equipment was the ability to translate into a mathematical formula the following law of physics: The height to which a liquid rises, or the depth to which it is depressed, in a capillary tube is inversely proportional to the diameter of the tube. Algebraically this becomes $h = k/d$, in which h represents the rise or depression, d the diameter of the tube, and k the constant of variation. But the translation of the law into the formula is not a teaching unit to a beginner in algebra, since the ability to make the translation implies, (1) some understanding of the use of literal numbers, (2) a knowledge of the meaning of inverse variation, (3) acquaintance with the form of the mathematical expression of an inverse variation, and (4) a knowledge of the significance of each symbol in the mathematical statement of the law.

The algebra curriculum resulting from the analysis of all the applications of algebra made in solving the problems of the physics text can not be given here. No one could propose it as a satisfactory course in elementary algebra, since there is no assurance that it would meet all the proper objectives of the subject. However, it may be worth while to point out some significant differences between this derived curriculum and the traditional one.

1. In the derived curriculum the fundamental operations with whole numbers and fractions receive very brief treatment and no difficult forms of fractions are treated. In contrast, think of the hours often spent on exercises in combining three or four fractions whose terms are trinomials—or worse!

2. In the derived curriculum, factoring does not appear, except as it may be involved in solving the single complete quadratic by the method of completing the square.

3. No mention whatever is made of simultaneous linear equations, simultaneous quadratics, laws of exponents, imaginary numbers, logarithms, progressions, the binomial theorem, and a few other topics usually treated in elementary algebra.

4. The derived curriculum places far more emphasis upon

the solution of formulas, ratio and proportion, and variation than these topics usually receive. A study of the summary of the algebraic equipment needed shows that most of the algebra employed appears in the formation, derivation and solution of formulas.

CONCLUSIONS.

1. The demands made upon the student's knowledge and skill in mathematics by the problems in Millikan and Gale's "A First Course in Physics" are not extremely heavy, but the student may not meet them fully because of misplaced emphasis in his courses in mathematics.

2. His arithmetical equipment should not fail him if he can multiply and divide integers and decimals up to at least twelve places with fair speed and with accuracy, and if he knows, and can apply, the rules of mensuration of the most common plane figures and solids.

3. If he has passed a course in plane geometry, his geometric equipment will probably be found adequate. In any case, no great number of problems require any knowledge of geometry.

4. It is in the field of algebra that the student's lack of equipment is most likely to appear. This is due to the fact that, in the traditional course, too little emphasis is placed upon the solution of formulas, ratio and proportion, and variation, and that such treatment as these topics receive is usually deferred to the last semester spent on the subject, whereas many students undertake the study of physics with only one year of algebra.

It is recognized that it is not the sole function of algebra to prepare for the solution of physics problems. Yet it is one of the objectives of the subject, and a very legitimate one. If an analysis of other activities in which algebra is employed should show results at all similar to the results of this study, then we should no longer hesitate to shift the points of emphasis in elementary algebra.

The article by Mr. Enatum Gist Gee in the magazine should have been credited to Edward Evans and Son of Shanghai who published it pamphlet form in both English and Chinese.

THE FOETAL PIG—A MAMMALIAN TYPE.

By W. J. Baumgartner,
University of Kansas, Lawrence.

The ultimate purpose of all educational endeavor is to enhance man's *wellbeing* and at the basis of this stands *being well.* The final aim of all our zoological study is to understand the structures and functionings in man's body better as well as its relationships to other bodies. Only with this essential knowledge in hand can man hope to follow properly the laws of good health and correct living.

With the thought of this essential knowledge in the back of his mind every teacher of zoology or physiology really wishes to show the conditions in the human body. But it is impossible to see internal organs of the human except in medical schools. So every teacher uses a vertebrate, usually a frog in a beginning course; but he would surely study a mammal if a good one were available. Many have or are using cats, dogs, rabbits, or rats for dissection, all of which have the advantage that they resemble man structurally comparatively closely. But there are several serious objections to the use of these mammals.

It is difficult to secure enough specimens, as is well shown by the prices demanded by dealers in zoological material who list injected cats at $24 to $36 per dozen, and the other mammals at corresponding prices. Such costs prohibit their use in the ordinary courses.

Many well-meaning people object to the use of small mammals for dissection as they think that their killing is cruelty to animals. Another objection is the fact that boys and girls often keep the domestic mammals as pets and they have a repellant feeling toward dissecting their bodies. Such a sentiment often appears in college students after they have taken two or three courses in zoology. This feeling never permits the student to do good work.

Were these objectons removed every teacher would want to show the mechanisms in a mammalian body to every student in biology. The writer believes he has found a small mammal which may be used in any or all classes either as demonstration specimen to be shown to the pupils or as specimens to be dissected by the students.

Foetal pigs which may be secured in great numbers at any large packing house where they are killed regardlessly would seem to meet all financial and sentimental objections. Properly preserved and injected, [1] the pig makes a well-sized, clean, non-

repellant, and practical specimen for class use. All the internal organs show up very clearly. The digestive tract is fully developed but practically empty and so not repulsive. The heart and the blood vessels have the adaptations for foetal circulation, and thus make it easy to explain the changes the blood circulation undergoes at birth. The organs of the urinary system reveal their relationships neatly. The reproductive systems show their constitutent organs clearly, and the different sized specimens show the testis in various positions in its descent into the scrotum. The nervous system can be easily dissected and studied as the bones are still soft.

After having used the foetal pig for many years in large classes in Comparative Anatomy the writer is ready to recommend its use as the type in all mammalian study. He believes that it might well serve as one of the types (the vertebrate) to be used in an elementary course in zoology or even in biology. While the structures are more highly developed, hence, more complex than those of the frog, it would be studied with more attention and interest by young people just because its structures are so much "like our own." The foetal pig deserves to become one of the much used types for dissection and demonstration because it is plentiful, hence cheap, killed anyway, and is not repellant to the student. It shows all the essential systems in a very clear and satisfactory way.

NEW BRAIN DISEASE CAUSES JAPANESE EPIDEMIC.

A mysterious and unidentified disease has caused a severe epidemic in Japan which appeared first in provinces bordering the inland sea and then spread over the whole island empire. The first reliable reports of the outbreak have recently been received by the Health Section of the League of Nations at Geneva.

The new disease was at first reported unofficially as cerebro-spinal-meningitis and then it was thought to be encephalitis lethargica, the so-called "sleepy sickness" which has been troublesome here and in Europe since the War. Finally it was found to be a hitherto unidentified epidemic disease involving the central nervous system, including the brain.

The explosive character and the intensity of the new disease that appeared in July and continued in epidemic form at last reports surpass even the outbreaks of encephalitis and acute poliomyelitis, or infantile paralysis, which have been particularly acute in recent years. The incidence was nearly 3 per 1,000 inhabitants in the most seriously affected province, Kagawa, and the mortality is reported as 60 per cent.

[1] Directions for preserving and dissecting are given in Baumgartner's "A Laboratory Manual of the Foetal Pig"——MacMillan.

A MATHEMATICS CROSS-WORD PUZZLE.

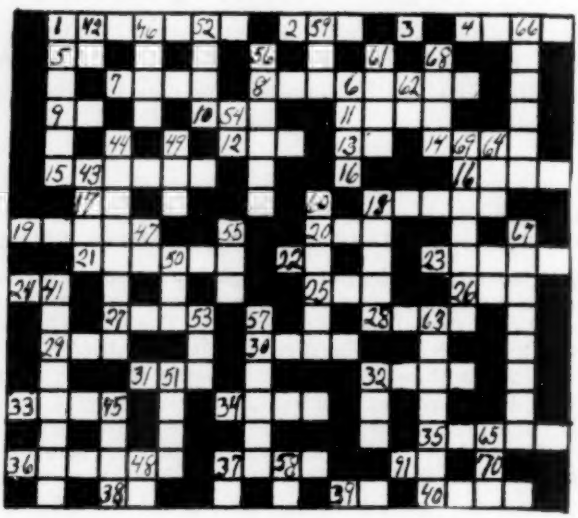
By Frederick A. Keniston,
Congregational High School, Augusta, Maine.

The cross-word puzzle is not only becoming more popular as a diversion, but also is finding extensive useful application. Already they have been introduced in the curricula of a few colleges and secondary schools, but in most of these instances only as an aid to vocabulary building.

Although to narrow down the words employed in a puzzle to strictly mathematical terms may seem impracticable, it is not, for a puzzle of this kind may be used in extra-curricula work, such as mtahematics clubs, to great advantage. Inasmuch as the purpose of a mathematics society in most high schools, is to stimulate interest in that subject, to solve a purely mathematical cross-word puzzle accomplishes this purpose. The solution of this easy puzzle will not only increase the interest in mathematics, but will also serve as a test of one's knowledge of the terms and expressions used in the elementary courses of that science.

After the students have become proficient in the solution of the mathematics puzzle, further advantage may be taken of this novel work by having pupils endeavor to make up an original one of their own. Whereas it is comparatively easy to originate a cross-word puzzle by using any work in the English language, it is very much more difficult to form one of strictly mathematical terms.

The following puzzle may, we hope, serve as an added stimulus to your mathematics clubs and be of great use to such organizations.



Horizontal

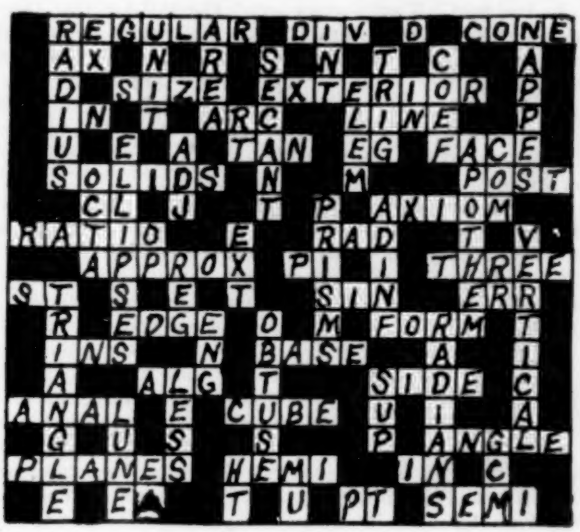
1. Systematic.
* 2. Separate.
3. 500.
4. A geometric solid.
* 5. An apodeictic rule.
7. Magnitude.
8. Outlying.
* 9. Unit of length.

Vertical

1. Circumference ÷ 2π.
41. The simplest polygon.
*42. Problem.
43. Eight (prefix).
44. One of the conic sections.
45. Formed by arcs of two circles meeting on sphere.
46. One.

10. Portion of a curved line.
11. That of one dimension.
*12. Touching.
*13. For example.
14. Surface.
15. Cubics.
*16. Geom. assumption.
17. 150.
18. A self-evident truth.
19. Fraction.
*20. Surd.
*21. Nearly.
22. 3.1416+.
23. Trio.
*24. Of invariable direction.
*25. Trigonometric ratio.
26. To make a mistake.
27. Arris.
28. Outline.
*29. Draw within.
30. Foundation.
*31. Elem. branch of math.
32. Face.
*33. Kind of proof.
34. Unit of volume.
35. Formed by a no. of lines meeting at a common point.
36. Level surfaces.
37. Half (prefix).
*38. Every.
*39. Dot.
40. Divide into two.
57. Naught.
70. 100.
*91. Measurement of length.
*47. Converse.
*48. Every.
*49. Next to.
*50. Orderly.
51. Minus.
52. Extent.
*53. Application of math. and science in industry.
*54. Not oblique.
*55. Outside.
*37. Altitude.
56. A trigonometric function.
57. ∠ 90° and ∠ 180°.
58. Greek letter used to designate angles.
*59. Inside.
60. Solid with faces □s and bases ~.
*61. A branch of math.
* 6. Rudimentary.
*18. To infinity.
*32. Two together equals 180°.
*62. A common measure.
63. 180° ÷ π (plural).
*64. Two ∠s whose sum = 90°.
*65. Greatest measure of a no. of things.
66. A conic surface of two parts.
67. Upright.
*68. One or more symbols used as a multiplier.
69. A line ⊥ the side of a polygon from its center.

(*Before a number means that it is an abbreviation).



ACTIVITIES OF THE NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

Two meetings of the Association have been held this school year. The annual meeting was held at Tufts College Nov. 15th and another was held at New London, Conn., Dec. 6th. Both of these meetings were well attended by secondary school people and college professors. As usual this association has attempted to correlate the work of its members so that both groups of teachers will find the meetings of value and interest.

The next meeting was held Feb. 14th at Boston English High School under the direction of the Central Division of the Association with Mr. Shipley Ricker, Woburn High School, chairman. The program was planned as follows:

Executive Committee meeting.

"Models used in teaching Organic Chemistry"—Prof. A. L. Pouleur, Wheaton College.

"Some experiments with nitrates"—Mr. Charles H. Stone, English High School.

"Some applications of Chemistry applied to the Textile Industry"—Prof. L. A. Olney, Lowell Tech.

Lunch.

Business meeting—

a. Committee reports.

b. Election of new members.

Motion picture. "The Fountain of Youth."

REPORT OF THE DECEMBER MEETING OF THE NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

The Ninetieth meeting of the N. E. A. C. T. and Eighth meeting of the Western Division of the Association was held December 6 at New London, Conn.

The morning program consisted of a thorough inspection of the U. S. Submarine Base. Transportation was furnished to and from the Base by a U. S. tug and all present enjoyed the sail up the Thames river. At the wharf the members were divided into small groups. Under the direction of trained lieutenants, we were shown the workings of the base. Especial attention was given to the "subs" themselves. Each visitor was given plenty of opportunity to ask questions and have piece of apparatus explained. After the trip back to New London an excellent lunch was furnished at the Chapman Technical High School by the Domestic Science department of that school.

The afternoon meeting consisted of election of officers, new members and committee reports. Professor Charles R. Hoover, Wesleyan University, was elected Division Chairman to succeed Mr. Leslie O. Johnson, who had been chairman for the past four years.

Professor Charles E. Dimick, U. S. Coast Guard Academy, addressed the members on "Relativity." The address was entirely non-mathematical and was thoroughly enjoyed. Dr. Jackson, Rhode Island State College, explained the Chemistry Contest that was held at that institution in the Spring of this year. Copies of that examination were distributed. The meeting was closed by a series of moving pictures furnished through the courtesy of the Bureau of Mines on the "Story of Steel." After the meeting the school laboratories were inspected and several members visited the laboratories of the Connecticut College for Women.

The following dates for future meetings were announced:

February 14, 1925, Boston English High School, Central Division.

May 2, 1925, Exeter Academy, Exeter, N. H., Northern and Central Division.

May 16, 1925, Mt. Hermon Academy, Mass., Western and North Division.

October , Rhode Island, place undecided, Southern Division.

November 14, 1925, Wheaton College (Annual meeting), Central Division.

December 5, 1925, Bridgeport High Conn., Western Division and New York Chemistry Teachers Club.

RURAL MAIL SERVICE.

Few institutions in the history of American progress can be credited with a more salutary effect upon the march of that progress than the Rural Mail Service of the Post Office Department.

No other single instrumentality has done more than the Rural Mail Service toward "bringing the city to the country," and relieving the prosaic existence of farm life, or has been as effective in establishing closer contact between the farmer and his markets. It has been the most important factor in making agriculture an exacting business instead of its one-time precarious classification which conveyed no broader meaning than "tilling the soil."

Twenty-nine years ago the farmer, and his wife, and children, led an existence of almost complete isolation, living upon widely scattered farms, some of them miles apart. They had comparatively little communication with their neighbors or the outside world, except that derived from weekly trips to the adjacent village. More often than not the farmer lost a full day's work and his crops were neglected in order to obtain expected mail at the village post office.

In those days the farmers' mail consisted largely of communications from relatives and friends. Today the daily mail includes, usually on the very date of publication, the metropolitan newspaper, containing market reports and agricultural news; the weekly and monthly farm journals and magazines, and business letters from the village merchant and the more pretentious establishment in the distant city. All of these are now brought to his door or to the box a few yards away.

The rural carrier is the farmer's post office and his agent. Through him he conducts transactions for the sale of his live stock, grain, and other farm produce. From him he buys stamps and pays his bills by postal money order. In short, the letter carrier is the medium that has transformed the once secluded habitant of the rural district into a cosmopolitan citizen, conversant with current affairs and occupying a larger place in the destinies of a great nation.

History.

It was Postmaster General John Wanamaker who first officially suggested in 1891 the rural mail idea to Congress. The plan was fought in the legislative branch of the Government for five years before it was given a try-out.

The first bill authorizing the establishment of the service was introduced in the House by Representative James O'Donnell of Michigan, January 5, 1892. It carried an appropriation of \$6,000,000 but failed of passage. A year later Congress was induced to appropriate \$10,000 for experimental purposes followed in 1894 by \$20,000 more. Mr. Wanamaker, believing the amount insufficient even for experimental service, declined to use the money.

On January 9, 1896, $10,000 was added by Congress and on October 1, the same year the first experimental rural delivery service was established simultaneously on three routes in West Vigrinia, one from Charlestown, one from Uvilla, and one from Halltown. From this small beginning, nine months later found the service operating on 82 routes emanating from 43 post offices in 29 states. Twenty-eight years later, or June 30, 1924, the Rural Mail Service had grown to 44,260 routes with a total mileage of 1,205,714.

In comparison with the insignificant appropriation of $10,000 made by Congress more than a quarter of a century ago to inaugurate the service, it now requires an annual expenditure of $89,250,000 to keep it functioning.

The first county to be completely covered by Rural Mail Service was Carroll County, Maryland, where county service was established December 20, 1899. There are very few counties in the country today that are not honeycombed to the uttermost corners with free mail delivery.

By 1915, 26,080 fourth class post offices had been discontinued as a result of the extension of the Rural Mail Service. It is estimated that an annual saving of $1,613,040 was accomplished by the discontinuance of these offices while the elimintion of star, or contract, routes is estimated to save $3,482,670 per annum.

When the service was first inaugurated the salaries of rural carriers was only $200 a year. They may now get as much as $2,160 a year, depending on the length of the routes, while the motor routes of 50 miles or more pay salaries of $2,450 to $2,600.

Under the administration of H. H. Billany, present Fourth Assistant Postmaster General, a marked increase in rural delivery facilities has been made, the number of routes climbing from 43,649 to 44,760; the mileage from 1,159,239 to 1,205,714 and the number of individuals served from 29,113,883 to 29,921,123.

Illinois leads the nation both in the number of rural routes and in mileage, there being 2,637 routes covering a distance of 70,677 miles in that state. Ohio is second with 2,542 routes and a mileage of 63,820; Missouri third with 2,252 routes covering 56,074 miles; Iowa fourth with 2,229 routes covering 60,734 miles; Texas fifth with 2,193 routes covering 59,998 miles; Pennsylvania sixth with 2,036 and 53,385 respectively, Kansas seventh with 1,902 and 55,464 respectively; and New York eighth with 1,863 and 47,130, respectively.

Figures for other states are:

State	*Number of Routes*	*Mileage*
Indiana	1,845	54,795
Michigan	1,830	50,703
Wisconsin	1,725	45,540
Minnesota	1,720	49,162
Georgia	1,635	47,008
Tennessee	1,618	40,295
North Carolina	1,402	35,499
Oklahoma	1,258	38,077
Nebraska	1,173	33,590
Alabama	1,165	30,943
Virginia	1,145	26,887
Mississippi	1,006	26,884
Kentucky	915	22,497
South Carolina	892	22,797
North Dakota	833	25,008

State	*Number of Routes*	*Mileage*
Arkansas	746	18,962
South Dakota	712	21,602
California	490	16,228
Maine	484	11,394
West Virginia	449	10,373
Maryland	429	10,542
Washington	415	11,554
Colorado	353	13,478
Vermont	341	7,916
Louisiana	337	8,892
New Jersey	306	7,922
Florida	292	10,052
Massachusetts	285	7,344
Oregon	280	7,959
Connecticut	268	6,393
New Hampshire	248	5,840
Idaho	222	6,030
Montana	204	5,920
Delaware	103	2,758
Utah	62	1,548
New Mexico	59	2,191
Rhode Island	45	1,080
Arizona	35	1,031
Wyoming	34	1,101
District of Columbia	4	115
Nevada	4	125
Hawaii	1	17

ARTIFICIAL GASOLINE.

By Dr. Edwin E. Slosson.

One of the most pressing problems of the present time is: What are we going to do when the oil runs out? If that question is not answered within the next ten or twenty years, the pressure on parking space will automatically be relieved through the growing scarcity of automobiles, aviation will remain a rarity and the small shop will tend to extinction through loss of its handy engines.

Already the question has become acute in countries less oily than ours. In England, Germany and France, chemists are hard at work trying to invent ways of making something to match the natural petroleum that is still being so recklessly wasted with us. The three countries are pursuing different ways toward the solution of their common problem, and all have recently reported some measure of success in getting gasoline from coal.

The British Department of Scientific and Industrial Research is experimenting in low temperature carbonization and has worked out a process that gives a gaseous fuel for local use, a liquid fuel suitable for motors, and a solid smokeless fuel, which they call "coalite," for household and industrial purposes.

In Germany the Bergius process of treating powdered coal with hydrogen under high temperature and pressure is said to be capable of converting low-grade lignite into a synthetic petroleum equal to the natural.

In France, a Rumanian chemist, Georges Olivier, in collaboration with

a French mining engineer, Charles Andry-Bourgeois, has invented a process claimed to be capable of converting coal, wood or any kind of carbonaceous material into gasoline of higher heating value than that obtained from petroleum. This is accomplished by the aid of certain catalysts which have the power of effecting the desired combination of carbon with hydrogen at high temperatures. Exactly what these catallysts consist of is not revealed in the account of the process given in the October issue of "La Science et La Vie" but they are stated to be made of certain metallic powders spread upon infusorial earth, clay, pumice charcoal and other porous bases.

The first stage of the process is similar to the familiar method of making coke and illuminating gas. The coal or lignite is mixed with from five to twenty-five per cent of lime, soda or alumina and heated in tight retorts. The distillate of tar, ammonia and light oils is condensed and utilized. The coke remaining in the retort is converted into water-gas by the well known method of passing steam over it while red hot. Water-gas is a mixture of hydrogen and carbon monoxide, both excellent combustibles and both employed in later parts of the process.

The gaseous output of the coke oven consists of free hydrogen methane and more complex compounds of hydrogen and carbon. It is essential for the next step that there should be an excess of hydrogen. If the mixed gas contains less than fifteen or twenty per cent of hydrogen by weight more must be added. This additional hydrogen may be obtained from the water-gas or, if necessary, by decomposing water by the electric current.

The second stage of the process consists in passing these gases through an electrical furnace heated to 3,000 degrees centigrade. This transforms the methane into acetylene and changes the other hydrocarbons into forms more active and ready for combination.

The gaseous mixture so obtained is next conducted under pressure through tubes containing the catalyzing agents. The temperature at the beginning of this, the third, stage of the process is about 150 degrees centigrade at first, but rises to 400 degrees at the end. Contact of the gases with these finely divided metals somehow causes the smaller molecules to hook up together and form larger molecules, and the colorless gas that entered the tube comes out as a colored oil, which, like the distillate of natural petroleum, looks red by transmitted light and green by reflected light. It contains about 75 per cent of very light gasoline.

In the fourth and final stage this colored oil is again passed over metallic catalyzers with an excess of hydrogen at a temperature of 180 degrees. The finished product is a light limpid colorless liquid having a very agreeable odor. It consists largely of what the chemists calls the "hydrogenated compounds of the benzene series," such as cyclohexane. In composition it consists of about 86 per cent of carbon, 13.5 per cent of hydrogen, with very little oxygen and less sulfur.

The process seems pretty complicated but according to figures of M. Olivier gasoline can be manufactured from the French lignites at a cost of twelve cents a gallon, which is less than a third the present price of gasoline in France. The initial plant constructed at Asnieres is expected to turn out a thousand tons a day. Twenty-five per cent of the carbon in the original coal comes out in the form of gasoline. The rest is mostly employed in heating the gas and apparatus and running the engines.

PROBLEM DEPARTMENT.

CONDUCTED BY J. A. NYBERG,
Hyde Park High School, Chicago.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and solve problems here proposed. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them.

Address suggestions and problems to J. A. Nyberg, Hyde Park High School, Chicago.

LATE SOLUTIONS.

847. *J. S. Georges, University High School, Chicago.*

854. *T. Dantowitz, Kensington H. S., Philadelphia, Pa.*

SOLUTIONS OF PROBLEMS.

856. *Proposed by D. L. Mackay, New York, N. Y.*

ABC is a scalene triangle. On AC the square ACDE is constructed, and on BC the square BCFG. The altitude to AB is CH. Prove that the lines BE, AG, CH are concurrent.

I. *Solved by Michael Goldberg, Philadelphia, Pa.*

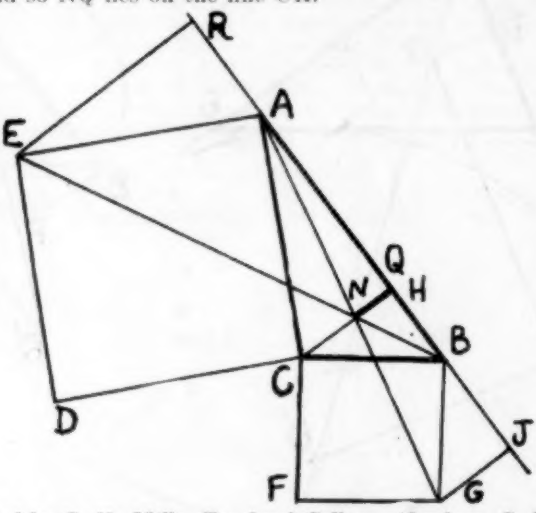
Draw ER and GJ perpendicular to AB produced in both directions. Let EB and AG intersect at N. Draw NQ and CH perpendicular to AB.

Then △ AER = △ CAH so that ER = AH; and △ BCH = GBJ, so that GJ = HB; and RA = CH = BJ.

From the similar triangles NQB and ERB, we get NQ/ER = QB/RB or NQ/AH = QB/RB. From the similar triangles NQA and AGJ we get NQ/GJ = AQ/AJ or NQ/HB = AQ/RB. Hence

$$NQ \cdot RB = AH \cdot QB = HB \cdot AQ$$

Hence, AH/AQ = HB/QB, from which it follows that H coincides with Q, and so NQ lies on the line CH.



II. *Solved by C. N. Mills, Teachers' College, Aberdeen, S. D.*

Use the point C as the origin of coordinates, CB as the positive x axis, and assign the following coordinates: C(0,0); A(b, c); B(a, 0). Then the coordinates of G are (a, $-a$), and of E are ($b-c$, $b+c$). The equations of the required lines are:

$$\begin{array}{llll} BE: & (b+c)x + (a-b+c)y & -a(b+c) & = 0 \\ AG: & (a+c)x + (a-b)y & -a(b+c) & = 0 \\ CH: & (a-b)x - cy & & = 0 \end{array}$$

The condition for concurrency is the vanishing of the determinant

$$\begin{vmatrix} b+c & a-b+c & -a(b+c) \\ a+c & a-b & -a(b+c) \\ a-b & -c & 0 \end{vmatrix}$$

Adding the elements of the third row to the elements of the first row gives a determinant having two rows (the first and second) the same. Hence the value of the determinant is zero, and the lines are concurrent.

The theorem holds true when the squares are turned inward. The points then have the following coordinates: $G(a, a)$ and $E(c+b, c-b)$. The equations of the required lines are:

$$\begin{array}{llll} BE: & (b-c)x - (a-b-c)y & -a(b-c) & = 0 \\ AG: & (a-c)x - (a-b)y & -a(b-c) & = 0 \\ CH: & (a-b)x - cy & & = 0 \end{array}$$

and the determinant again equals zero.

When $\angle C = 90°$, then $b = 0$ in all of these equations.

Also solved by *George Sergent, Guatemala, C. A.;* and *J. F. Howard, San Antonio, Tex.*

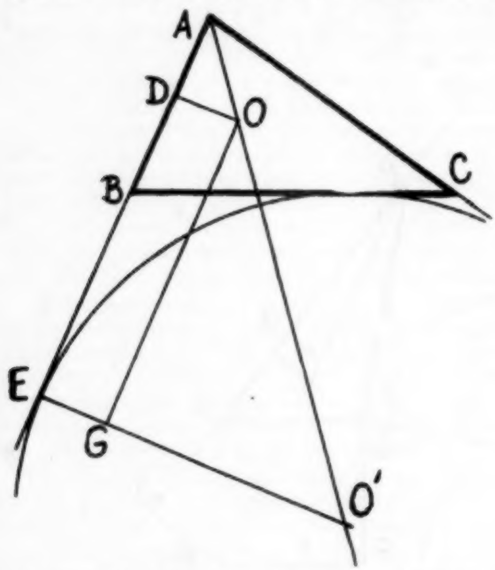
857. *Proposed by F. A. Cadwell, St. Paul, Minn.*

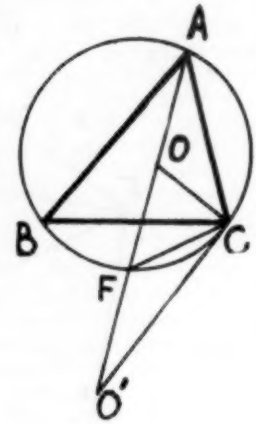
Construct the triangle having given one side, a, the opposite angle, A, and the distance, e, between the center of the inscribed circle and the center of that escribed circle which is opposite A.

I. *Solved by J. F. Howard, San Antonio, Tex.*

Let O be the center of the inscribed circle, and O′ the center of the escribed circle. $AD = s - a$; $AE = s$; $DE = a$. Draw $OG \parallel AE$. Then $OG = DE = a$, and $\angle GOO' = \angle EAO' = \frac{1}{2}A$.

Hence $OO' = a \sec \frac{1}{2}A$; that is, e is given if a and A are given. The problem is impossible because of insufficient data.





II. *Solved by Nelson L. Roray, Metuchen, N. J.*

Let ABC be a triangle with its circumscribed circle, F the midpoint of the arc BC, O the center of the inscribed circle, and O′ the center of the escribed circle within the angle A. Then $\triangle OCO'$ is a right triangle and F is the midpoint of OO′; hence the chord CF is one half of OO′.

Also $OO' = a \sec \frac{1}{2}A$, and $CF = \frac{1}{2} a \sec \frac{1}{2}A$; that is, OO' is a function of a and A. Therefore when we are given a, A, and OO' we are not given three independent parts of the triangle and the solution is either impossible or indeterminate.

If $OO' \pm 2CF$, the construction is impossible.

If $OO' = 2CF$, the construction is indeterminate and is as follows: Construct on a, or BC, the segment of a circle containing $\angle A$ as an inscribed angle. From the midpoint of the arc BC draw a chord to any part of the arc containing $\angle A$, and ABC will be the required triangle.

In addition we may remark that the locus of O is an arc through B and C with CF as a radius and F as a center.

Also solved by *T. Dantowitz*, *George Sergent*, and *Michael Goldberg*.

858. *Proposed by Norman Anning.*

If x, y, z are unequal and if

$$\frac{xyz}{y+z} x^2 = \frac{xyz}{z+x} y^2$$

show that each equals $\dfrac{xyz}{x+y} z^2$

Solved by R. C. Staley, Eagle Co., H. S., Gypsum, Colo.

The given relation can be written as

$$\frac{xyz(x-y)}{(y+z)(x+z)} = (x+y)(x-y)$$

or $xyz = (x+y)(x+z)(y+z)$.

Substituting this value of xyz in the three quantities, we see that each reduces to $xy + yz + xz$.

Also solved by *J. Murray Barbour, Ardmore, Pa.; T. Dantowitz; Michael Goldberg; J. F. Howard;* and *C. N. Mills.*

859. *Proposed by C. E. Githens, Wheeling, W. Va.*

Given a quadrilateral, no two sides of which are equal or parallel, but with the diagonals perpendicular to each other. Find integral values for the sides of the quadrilateral and the segments of the diagonals.

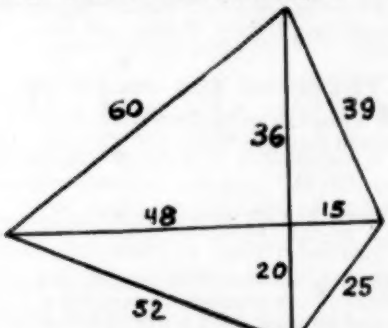
I. *Solved by J. Murray Barbour, Ardmore, Pa.*

Let $4ab$, $2a(b^2-1)$, $(a^2-1)(b^2-1)$, and $2b(a^2-1)$ be the segments of the diagonals, taken in clockwise order. Then, since the diagonals are perpendicular to each other, the sides of the quadrilaterals will be the hypotenuses of four right triangles of which the legs are the segments of the diagonals.

The sides of the quadrilateral are therefore

$$2a(b^2+1),\ (a^2+1)(b^2-1),\ (a^2-1)(b^2+1),\ 2b(a^2+1).$$

If a and b are integral, these values are integral.



II. *Solved by Raymond F. Schnepp, Chaminade College, Clayton, Mo.*

Denote the sides of a right triangle by a, $b = \frac{1}{2}(a^2-1)$, $c = \frac{1}{2}(a^2+1)$. We can then obtain the following sets of integers which satisfy the Pytha-

gorean theorem: A(3, 4, 5); B(5, 12, 13); C(7, 24, 25); D(9, 40, 41), E(11, 60, 61). If now we multiply the a, b, and c of one set by a; and multiply the a, b, and c of another set by b, we obtain integers that must satisfy the problem. Thus, sets A and B can be combined as follows:

5 · (3, 4, 5) gives (15, 20, 25) 3 · (5, 12, 13) gives (15, 36, 39)
12 · (3, 4, 5) gives (36, 48, 60) 4 · (5, 12, 13) gives (20, 48, 52)

These numbers may now be arranged as illustrated in the figure where the a and b are the segments of the diagonals, and the c are the sides of the quadrilateral.

By indicating only the segments of the diagonals, other solutions may be written briefly as follows:

From sets A and C: 21, 72, 28, 96
From sets B and C: 35, 120, 84, 288
From sets B and D: 45, 200, 108, 480
From sets C and D: 63, 280, 216, 960

Also solved by J. F. Howard, and the Proposer.

860. *For High School Pupils. Proposed by I. N. Warner, State Normal School, Platteville, Wis.*

On a certain invoice for some goods, a total discount of 38.8 per cent was given. This was the result of a series of three discounts, the first 20 per cent, the second 10 per cent. What was the third discount?

I. *Solved by Robert H. Stevens, East Orange H. S., N. J.*

Let A = the original price, and x = the third discount, in %.

Then since each successive discount is reckoned on the previous marked down price,

$.20A + .10(A - .20A) + .01X\ [A - .20A - .10(A - .20A)] = .388A$

Solving for x: $x = .15$ or 15%

II. *Solved by Henton Brenan, Redlands H. S., Cal.*

Let \$100 equal the price of the goods. Then 38.8% would leave \$61.2 Take 20% of \$100 which would leave \$80. Then 10% of \$80 which would leave \$72. Then take the difference of \$72 and \$61.2 and divide that by \$72 which would leave \$15%. The third per cent = 15%.

III. *Solved by Sylvia Rosengard, Dickinson H. S., Jersey City, N. J.*

Let \$1,000 = amount of invoice. Then 61.2% of \$1,000 = \$612 (total amount after discount of 38.8%).

80% of \$1,000 = \$800 (amount after deduction of 1st disc., 20%)
90% of \$800 = \$720 (amount after deduction of 2nd disc., 10%)
\$720 − \$612 = \$108 (amount still to be reduced)
\$108 ÷ \$720 = % of last discount. (We are given the product \$108 and the multiplicand \$720, to find the multiplier, % of last discount).
\$108 ÷ \$720 = .15 = 15% (rate of last discount).

Also solved by *Yetta Auslander, Sylvia Epstein,* and *Mollie Gross* of the *Dickinson H. S., Jersey City;* and by *Theodore Byyny, Willis Cadwallader, Glenn Criss, Barry Dibble, Harold Hobbs,* and *Grace Oosterheert* of the *Redlands H. S., Cal.*

PROBLEMS FOR SOLUTION.

871. *Proposed by George Sergent, Guatemala, C. A.*

(Suggested by problems 841, 856.) On the side AC of any △ ABC the square ACDE is constructed, and on the side BC the square BCFG. Prove that the lines AF, BD, and EG are concurrent.

872. *Proposed by D. L. Mackay, New York, N. Y.*

Given A′, B′, C′, the centers of the squares constructed on the sides of △ABC, to construct the triangle △ ABC.

873. *Proposed by C. E. Githens, Wheeling, W. Va.*

Prove that the cube of any number when divided by 6 leaves the same remainder as does the number itself when divided by 6.

874. *Proposed by Donald C. Steele, Greensburg, Pa.*

In a rectangular room 12 ft. by 15 ft., a strip of carpet 3 ft. wide is placed diagonally so that the corners of the carpet touch the sides of the room. Find the length of the carpet.

875. *For High School Pupils. Proposed by Norman Anning, Ann Arbor, Mich.*

Explain the magic in the following: Choose any number except 0 or 1, and perform the following operations in succession (a) subtract from 1, (b) find the reciprocal, (c) subtract from 1, (d) find the reciprocal, (e) subtract from 1, (f) find the reciprocal. Now, if you have worked correctly, I can tell what your result is.

SCIENCE QUESTIONS.

Conducted by Franklin T. Jones,

The White Motor Company, Cleveland, Ohio.

To Readers of School Science and Mathematics:

You are invited to propose questions for solution or discussion.

You are asked to answer questions.

Examination papers are always desired. Send in your own papers or any others. Some are interested in college entrance examinations, others in school or college examinations. All are desired.

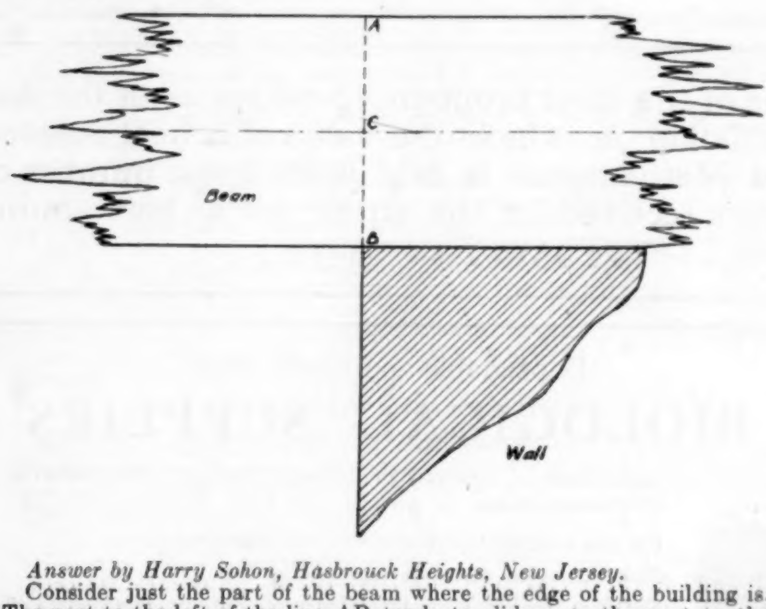
Please address all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E., Cleveland, Ohio.

SOLUTION OF PROBLEMS.

447. *Proposed by James W. Wilbur, Peoria, Ill.*

Imagine a rectangular stick, such as a 2"x4", extending a given distance, as 6 feet, horizontally from a flat roof, there being a weight of 200 lbs. at the outer end and the part on the roof being held down by a force 10 feet from the edge of the roof.

Analyze the forces tending to rupture the stick at the edge of the roof and assign their numerical values.



Answer by Harry Sohon, Hasbrouck Heights, New Jersey.

Consider just the part of the beam where the edge of the building is. The part to the left of the line AB tends to slide over the part to the right. This shearing stress is equal to 200 pounds or for the whole surface it averages 25 pounds/in^2 (25 pounds per square inch.)

Second, there is tension in the fibers above the middle C and compression below C due to bending. At C the fibers are not under any stresses due to bending. This stress varies in different places and is a maximum

in the outer fibers; it being 2700 # /in^2 compression on the lower edge and 2700 # /in^2 tension on the upper edge, when the 2x4 is resting on the 2″ side.

Where v is the distance in inches from the center C to the fiber whose stress is sought and S the stress, the relation in this problem is:

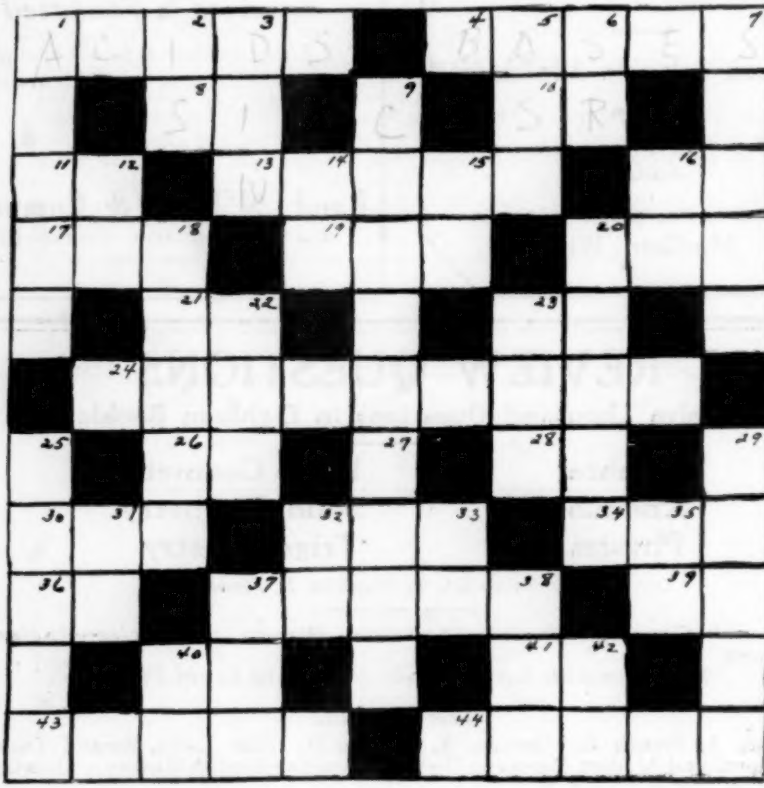
$$S = 1350\,V$$

Third, there is a tendency for the fibers to slide, one over the other. This is greatest at the middle C being 37½ # /in^2.

The formula for this stress, S, in terms of the distance, V, from the middle is:

$$S = \frac{75}{8}(4 - V^2)$$

460. *A cross word chemical puzzle* by *Mary Borries, Louisville Girls' School, Louisville, Kentucky.*



Horizontal.

1. Compounds containing hydrogen.
4. Opposite of 1.
8. Symbol of an abundant element.
9. Symbol of an element found in all organic compounds.
10. Same as vertical 6.
11. Symbol of a rare element.
13. Symbol of the elements found in a protein.
16. Symbol of an active element.

17. Suffix used to denote lower valence.
19. Source of many substances.
20. Common name of a mixture of the glyceryl esters of oleic, palmitic, and stearic acids.
21. Same as 41.
23. Symbol of a rare element found in pyrites.
24. A common metal.
25. Symbol for an inert gas.
26. Symbol of an element rare but widely distributed.
27. Symbol of an element mined in Louisiana.
28. Symbol of a metal.
30. Formula for a black precipitate formed when ammonium sulfide is added to a green solution.
32. Suffix denoting a salt.
34. A permanent color.
36. Symbol of an element found with platinum.
37. Latin name for a valuable metal.
39. College degree for chemists.
40. Symbol of a costly element with many uses.
41. The way electricity comes into the building. (Abbrv.)
43. Common name for potassium nitrate.
44. Very small particles.

Vertical.

1. A mixture of metals.
2. Part of the verb to be.
3. An inharmonious noise.
5. What you feel like when you can't write an equation.
6. Symbol of an element giving a red flame.
7. Products formed when horizontals 1 and 4 react.
9. The most valuable science.
12. Symbol of horizontal 37.
14. Symbol of an element found with horizontal 36.
15. Symbol of an element found in limestone and gypsum.
16. Same as vertical 15.
18. Same as vertical 7.
20. A substance without form.
22. Formula of a compound formed when iodine is spilled on copper.
23. A metallic element used in solder.
25. A negatively charged particle.
29. Methods used for determining the composition of a substance.
31. Same as horizontal 36.
32. Same as vertical 12.
33. Symbol of a very rare element discovered in 1896.
35. Symbol of an element named for a town in Sweden.
37. Same as horizontal 32.
38. A laboratory utensil used to protect from heat.
40. Same as horizontal 40.
42. Formula of a poisonous gas.

QUESTIONS FOR SOLUTION.

458. *Newspaper clipping*

How much *power* is used by these automobiles? Get some of your pupils to explain just what is the matter with this piece of advertising in the physical sense?

POWER OF CHEVROLETS.

"If the 1,000,000 Chevrolet cars used daily carried only five passengers averaging 150 pounds in weight each, the total haul would amount to 750,000,000 pounds. To move the same weight by rail would require the use of 12,500 box cars, each car of thirty tons capacity."

How much "power" will it take to haul 750,000,000 pounds on a level brick road (tractive resistance 40 lb. per ton)? How much on a dirt road (100 lb. per ton)?

459. *Proposed by A. G. Hayner, Bishop Colton School, Banjalose, S. India.*

AB is a uniform beam whose weight is W. B rests on a smooth inclined plane whose angle is γ. A has a string attached to it making an acute angle. B with beam and the other end of it is attached to a fixed point F. Find the condition that equilibrium may be possible, i. e., find the relation between γ and B.

NATURALIST SAYS MICE OFTEN BENEFICIAL TO MAN.

Mice are often useful to man, Vernon Bailey, naturalist of the U. S. Biological Survey, told the American Nature Study Society meeting recently.

There are many species of small mammals commonly known as mice, said Mr. Bailey, of which one-well known group, the European house mouse, has been so odious that it has given an undeserved bad name to all the rest. While many of the native American wild mice are also destructive to crops, and some to orchard and forest trees, there are some species that are friends of man. Notable among these is the grasshopper mouse. Their natural food consists largely of insects and other small animals, such as grasshoppers, crickets, beetles, scorpions, and a great variety of such earth-dwelling forms, as well as other small rodents of their own size or smaller. These little tigers of the mouse world supply the place of the useful moles and shrews, which do not to any extent inhabit the arid regions where these mice live

BOOKS RECEIVED.

The Kewaunee Book; The Kewaunee Mfg. Co.; Kewaunee, Wis.; 12 pages; 23x31 cm.; Paper, 1924; Kewaunee Mfg. Co., Kewaunee, Wis.

Teaching Agriculture, by James B. Berry. Department of Public Instruction, Pennsylvania. Pages XIV and 230, 14x19.5 cm. Cloth. 1924. $2.00. World Book Company, Yonkers, New York.

Modern Business Geography, Ellsworth Huntington, Yale University, Sumner W. Cushing, State Normal School, Salem, Mass. Pages—VIII plus 352, 24x16½ cm. Cloth, 1925. $2.00. Yonkers-on-Hudson, N. Y., World Book Co., Chicago.

Essentials of Algebra, David E. Smith, Wm. D. Reeve, Pages—IX plus 558. 13½x19½ cm. Cloth, 1924. $1.56. Ginn & Co., Boston.

Exercises in Bookkeeping and Business Problems, Harold E. Cowan, Dedham (Mass.) High School, Harold W. Loker, Pages—196, 19½x25 cm. Paper. 1924. $0.60. Ginn & Co., Boston.

Plane Geometry, John O. Pyle, Harrison Technical High School, Chicago. Pages—VII plus 279, 13½x19 cm. Paper. 1924. P. Blakiston's Son & Co., Philadelphia.

The Early Embryology of the Chick, Bradley M. Patten, Western Reserve University. Pages—XI plus 177, 16x24 cm. Cloth, 1924. $2.25. P. Blakiston's Son & Co., Philadelphia.

BOOK REVIEWS.

The Kewaunee Book, Kewaunee Mfg. Co., Kewaunee, Wis., 12 pages; 23x31 Cm.; paper, 1924; Kewaunee Mfg. Co., Kewaunee, Wis.

We have recently received a catalog from the Kewaunee laboratory furniture Co. This is by all odds one of the finest that has ever come to our attention.

Without doubt, the product of this firm is of such a nature that it will be difficult to duplicate either in quality of workmanship or character of the material entering therein.

The firm is aways ready to listen to suggestions by prospective buyers, being willing to construct tables or cases after specifications by the

purchaser. It is unique in having a plant of such a character that they can construct any form of laboratory apparatus that is demanded. They never turn out poor work.

Any one placing an order with the firm can rest assured that it will be delivered on time and according to specifications.

C. H. S.

Experimental Science, by S. E. Brown, Christ's College, Cambridge, Mass. Pages 419 to 531; 13x18½ Cm. Cloth, 1924. Cambridge University Press.

A beautiful little book on the subject of sound, written clearly and concisely and to the point, for secondary school pupils. It is not too rigid for this class of pupils.

The cuts and half-tones are splendidly executed.

The experiments cover the entire secondary school range.

There are many practical questions bearing on the experiments scattered through the work.

We can recommend the book for experimental work in sound to any secondary school.

C. H. S

Laboratory Experiments in Practical Physics, by N. Henry Black, Roxbury Latin School, Boston. Pages VIII plus 157; 20x27 Cm. The MacMillan Co., Chicago.

This is a splendid progressive book of secondary laboratory physics. It contains 65 splendid experiments, each one closing with a series of questions bearing upon that experiment.

The drawings are splendidly executed.

The directions for the experiments are clear and concise and such that any pupil counting on taking the subject will be able to understand them without any further assistance.

Instructors will not make any mistake by selecting this manual for their laboratory work.

C. H. S.

Paths to Success, by Harold G. Black, Hollywood High School, Los Angeles. Pages VII plus 304; 13x19 Cm. Cloth, 1924. D. C. Heath & Co., Chicago.

The idea in this volume is to present a series of modern essays on the chief subjects taught in the secondary schools of America. This list is not exhausted.

The people selected for these essays are persons of standing in their particular line of work. It is designed primarily to awaken and increase the reader's interest in the subject.

It is printed in ten-point type on uncalendared paper. At the end of each chapter there is a set of questions bearing upon the subject matter discussed in that chapter.

C. H. S.

Applied Physics, by W. D. Henderson, University of Michigan. Page 82. 20½x28 Cm. Paper, 1924; Lyons & Carnahan, Chicago.

This book, coming from the pen of this splendid instructor, cannot help but be one of the most practical and up-to-date laboratory manuals that have come from the press in a long time.

The object of the book has been to provide a series of greater laboratory exercises in secondary school physics, and also designed to be used with inexpensive apparatus. It gives to the pupil the fundamental experiences in teaching him the right method to proceed in order to attain a good working knowledge of physics.

The writer can recommend this laboratory manual in every respect.

C. H. S.

Outlines of Economic Zoology, by Albert M. Reese, Professor of Zoology in West Virginia University. Second edition. Cloth. 1924. 194 illustrations. pp. xiii plus 318. $2.50. P. Blakiston's Son & Co., Philadelphia.

The first edition of this book by the same author appeared several years ago practically unique in the field, as a college text, in its treatment of representative animals from the various phyla on a purely economic basis. It has been a valuable aid in placing a proper emphasis on the economic relationships of the various forms to man. It is a college text, but in its style and treatment it is also admirably suited for general reading for those who desire a knowledge of animals without going into minute scientific detail. The second edition brings the subject matter up to date including recent advances which have developed since the date of the first edition. The book merits wide use in college classes as a text and for collateral reading and it should be in the hands of every teacher of high school zoology or general biology.

J. I.

Early Steps in Science, by Hanor A. Webb, Professor of Chemistry and John J. Didcoct, Professor of Secondary Education, George Peabody College for Teachers. 1924. pp. xv plus 691. D. Appleton & Co., New York.

This text in general science is intended for the first year of the four-year high school course. The subject matter is not too difficult or technical and it is selected and arranged in such a way as to satisfy natural interests as they arise and stimulate new interests. Numerous practical questions for review are given at the end of the various sections. Directions are given for many home experiments and demonstrations. Hygiene instruction is carried along as a part of the various topics throughout the text. It is the evident purpose of the authors to avoid encroachment on the recognized subject matter of the special sciences and, while offering valuable information and training, to create a preliminary wide-spread interest in science which will recruit for the special sciences rather than compete with them. The thoroughly modern treatment should recommend this book highly to high school teachers and administrators.

J. I.

Health for Every Day and Health for Home and Neighborhood, by Maurice A. Bigelow, Professor of Biology, and Jean Broadhurst, Associate Professor of Biology, Teachers' College, Columbia University. pp vi plus 235 plus viii, and pp. vi plus 320, respectively. Silver, Burdett and Company, Newark, N. J.

Practically every recent attempt at modern curriculum reconstruction has been marked by an honest endeavor to include cumulative instruction in Health, directly or indirectly through the grades and into the high school. The task has not been an easy one. It is encouraging that persons as eminently qualified as the authors of these two books should set themselves to the task of helping administrators and teachers in the grades in their problems with regard to health instruction. The older method of attack through a study of anatomy of internal organs has been discarded by these authors as a useless waste of time. Emphasis is placed on accidents and other avoidable dangers. The method of approach from the nature-study basis has been used extensively. The pupils are set to solving problems. In this way they are brought face to face with conditions of personal health and civic well-being. The

text of the books is adequately illustrated by drawings and reproductions of photographs. Valuable suggestions to teachers by Laura Zerbes are appended to each book. Silent reading and other methods of attack are stressed.

Teachers of science in the elementary schools will be interested directly in these books as possible texts in the hands of their pupils or for supplementary reading. The books should be of interest to teachers of science in secondary schools in that they suggest a beginning of a solution, along modern lines, of the problem of unified health instruction for the schools.

J. I.

A Second Course in Algebra, by Edward I. Edgerton, B. S., Dickinson High School, Jersey City, New Jersey, and Perry A. Carpenter, Ph. B., West High School, Rochester, New York. Pages IV plus 461. 13½x19. 1924. Allyn and Bacon.

This book in the main follows the traditional algebraic development. There are numerous verbal problems. J. M. K.

Introduction to the Calculus, by William R. Longley, Ph. D., Professor of Mathematics in Yale University, and Wallace Alvin Wilson, Ph. D. Associate Professor of Mathematics in Yale University, with the Editorial Cooperation of Percy F. Smith, Ph. D. Professor of Mathematics, Yale University. Pages VII plus 452. 1924. $2.40. Ginn and Co.

This book is designed for sudents who have not had a course in Analytic Geometry. This subject is built up around the calculus. The standard applications are given after the student has learned to differentiate and integrate. By this arrangement the student is exposed for a longer period than is usual to the ideas underlying the calculus.

J. M. K.

Practical Calculus for Home Study, by Claude I. Palmer, Associate Professor of Mathematics, Armour Institute of Technology. Pages XX plus 443. 12½x20½ cm. Leather. 1924. McGraw-Hill Book Co., Inc. New York.

This book is not only attractive in appearance but is attractively written. The author develops each topic carefully keeping in mind the fact that the reader does not have the advantage of class discussion. While this book is written for home study, the reviewer sees no reason why it would not make an excellent text for class use. J. M. K.

Chemistry Experiment Sheets, by Martin Mendel, Jamaica High Schoo and Milton B. Brundage, Stuyvesant High School, New Yrok City. 1st edition. pp. vi plus 60. 20½x26½ cm. Loose leaf, in cloth cover with rings. 1924. Fordham Publishing Co., New York.

This manual provides some 60 experiments such as meet the college entrance requirements. Each sheet has a blank side for recording the results of the experiment. A preliminary sheet gives a number of cross section drawings so as to show the pupil what is wanted but at the same time compels him to make his own drawings at the proper place. Blank tables are provided for data to save the pupil's time. More than enough experiments for a years work are provided so that the teacher may select those that he deems most desirable. Leading questions to provoke thought are provided and general questions serve to correlate the laboratory and the text book work. The directions are clear and proper cautions are given to safeguard the worker. In addition to the usual experiments of inorganic chemistry there are a few organic experiments. Blue print making and the indentification of unknown substances are also taken up. The manual is well worth an investigation and trial.

F. B. W.

DIRECTORY OF SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the March and November issues of this Journal the names and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. This is extremely valuable information to all progressive teachers. Is your society listed here? Names are dropped when they become one year old.

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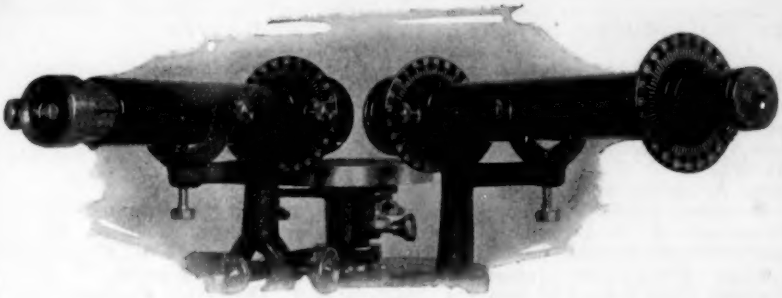

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